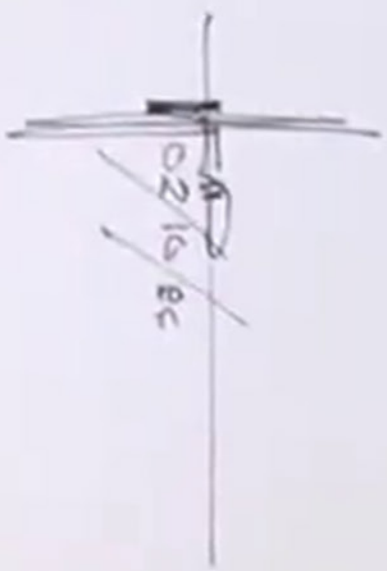
PROJECTIONS

To Neal East / a real time trip to see and sign this early collection. Lloyd Wise



"The whole essence of really good engineering is simplicity."

—GROVER LOENING

PROJECTIONS IN STEEL

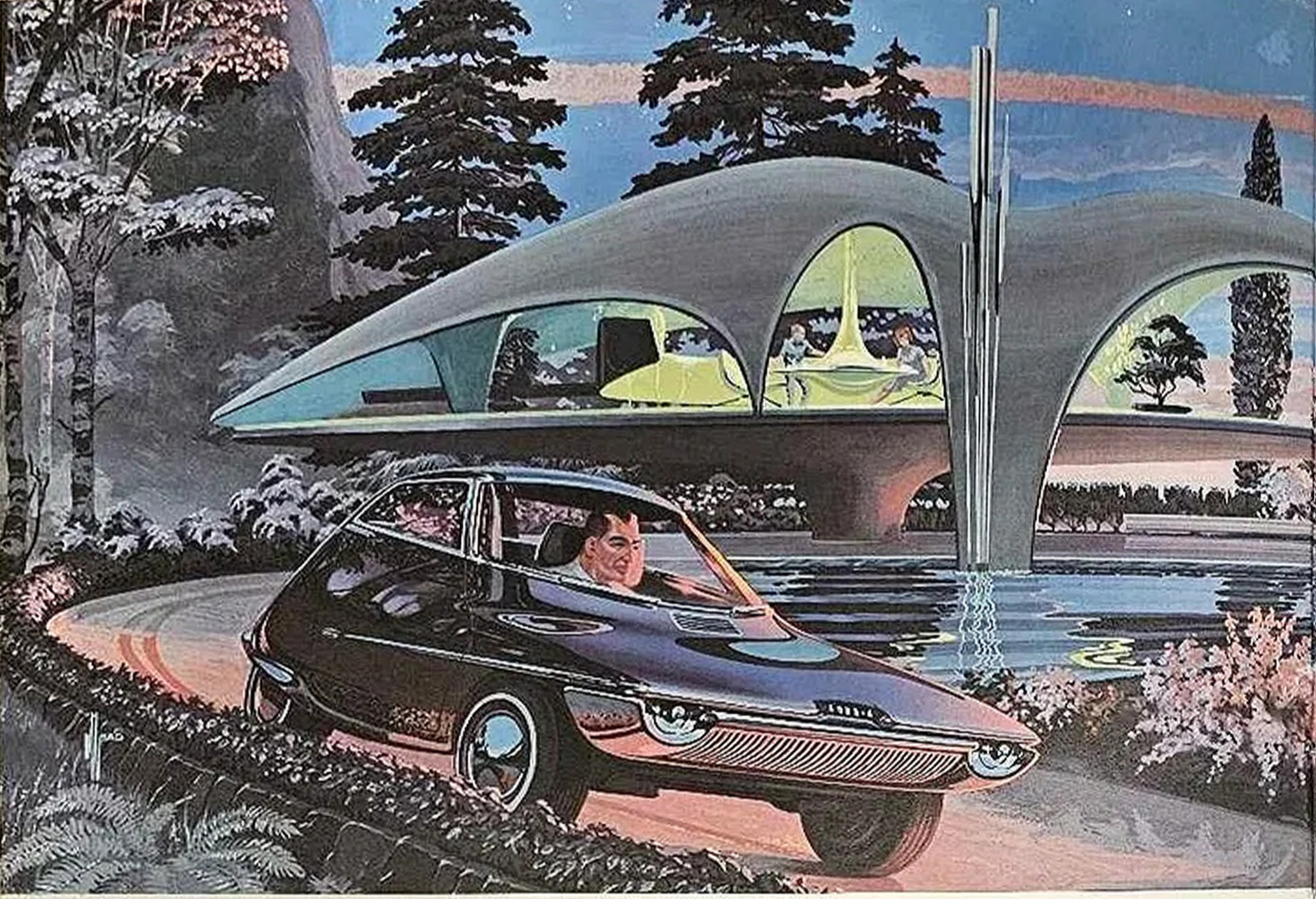
This is a book of engineering and styling ideas obtained from various sources—some already in use, some imaginary. It is intended as a tribute to the industry and its men. • The renderings and drawings are simply artists'

FOREWORD

Our age of space exploration is rapidly leaving behind it the leisurely pace of the craftsman and is creating in its place a kind of technical specialism. Such a tremendous change could take place only in a period of highly developed resources, advanced technical skills and creative ingenuity on the part of many industries and individuals.

There was a time when the automotive engineer was not only an investor but also the final authority on all the materials that went into his car or truck. Almost alone, he had to determine whether the materials met the requirements of the function. Many of his ideas could not be brought to reality because the number and variety of new materials available to him were so limited. Yet, it remained his problem to make parts function better at a lower cost. Now vehicles have become so complex that it is no longer possible for him to be an expert on all materials. Consequently, the development of present day products is the result of cooperative effort on the part of the engineers and their supplying industries.

It is the job of the materials producers not only to develop new materials which satisfy design and engineering problems, but also to suggest alternate applications, new concepts, material properties, availability and comparative prices which may increase the effective and economic use of these materials. United States Steel is continually developing new steels of interest to engineers, designers, and stylists. We hope the ideas on the current uses of steel presented in this book will help you in converting your ideas to practical reality.

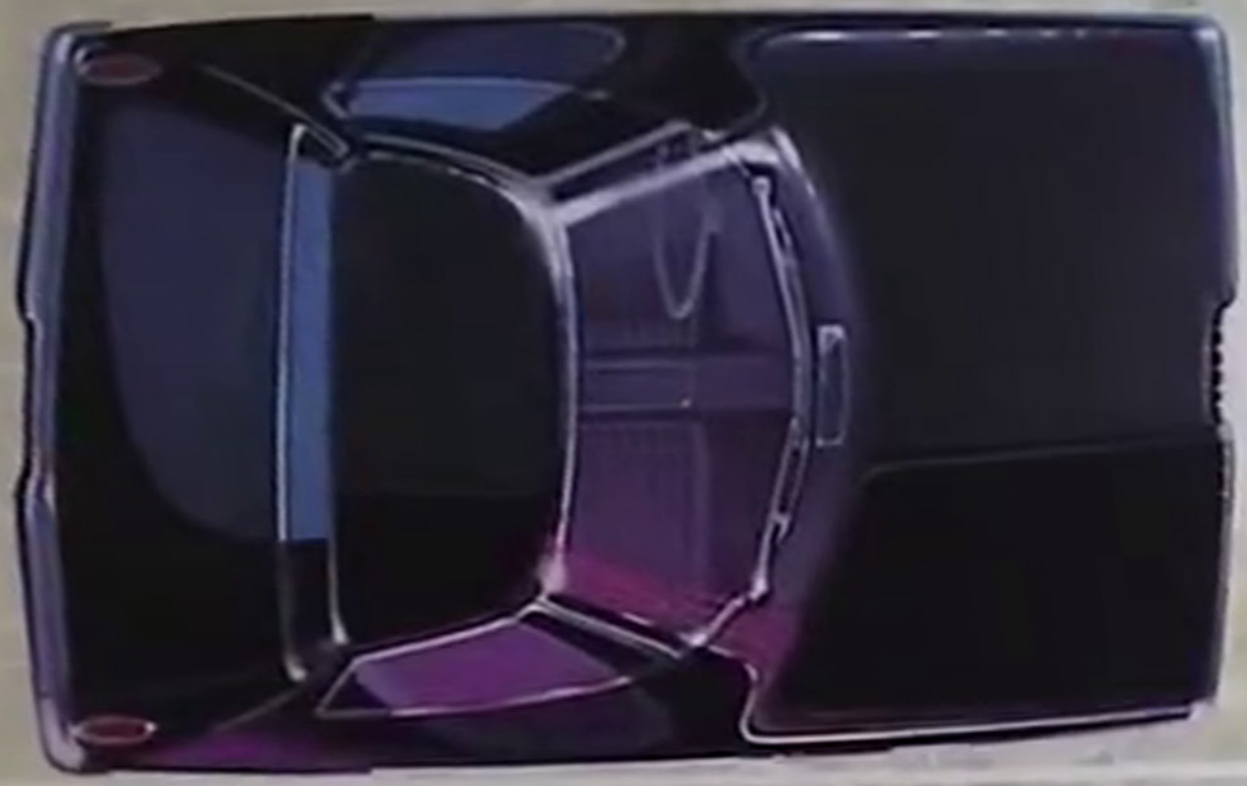


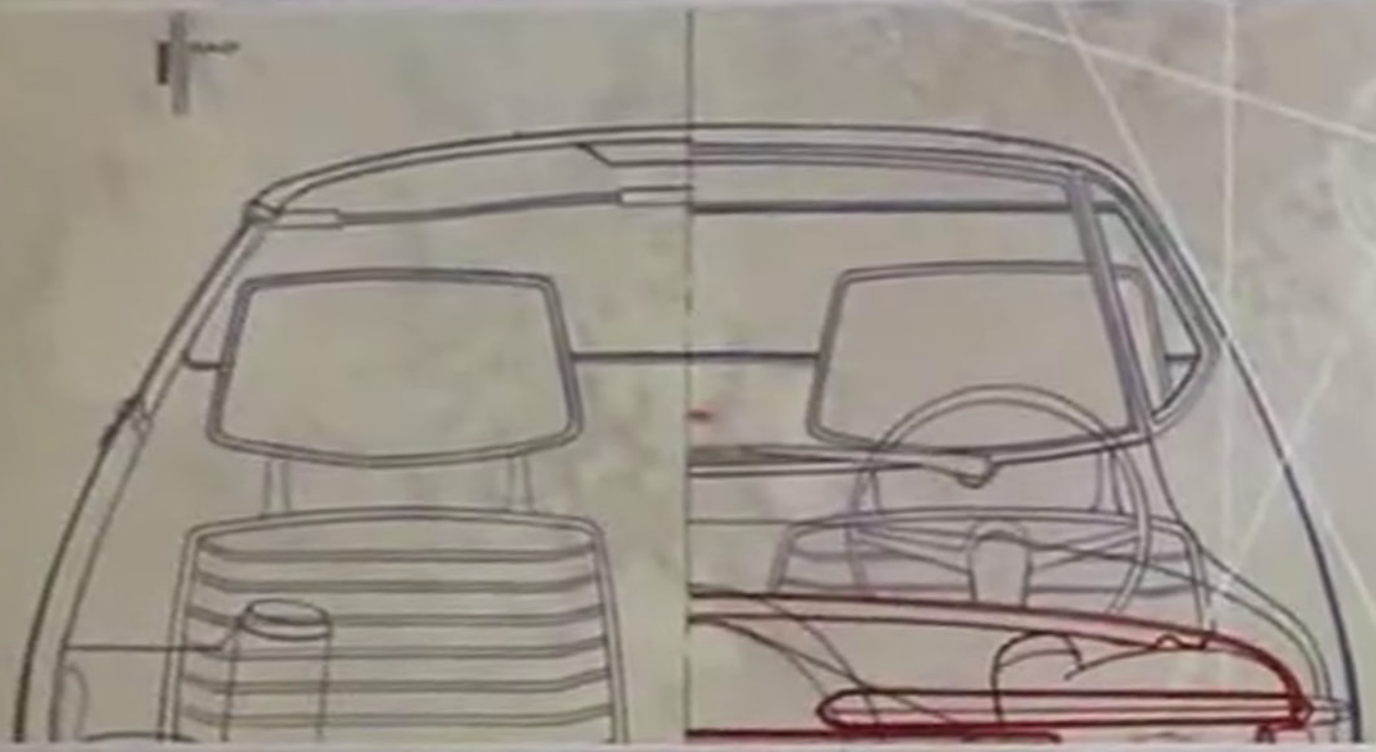
THE DESIGN OF CARS TO COME

This is lightness in design made possible through the ability of steel to perform dual functions of skin and structure. In this way the cowl, floor and quarter panels carry loads formerly carried by structural underbody parts. Inexpensive, versatile and extra light, this two-passenger car is designed for short-haul commuter-type transportation. It can be driven in all climates and under all road conditions with an absolute minimum of maintenance. Although small it is neither cramped nor uncomfortable.

since its minimum outside dimensions have been functionally (coordinated-designed) around the standard seating package. Light enough to give excellent performance and operating economy, it is remarkably stable in crosswinds because of its aerodynamic design. Adverse effects of lift on traction are also offset by this design.

From the engineer's and stylists' viewpoint, it is a concept in convolutions and shapes which can be readily designed and fabricated into present car bodies. Manufacturing teams are now realizing the greater advantages of large, lightweight, steel body panels since they reduce the necessity for the excessive number of braces and joints which are common today and which are difficult and expensive to cover. This design concept diminishes the fabricated look and presents a new, smoother exterior styling. Its promises are great for the near future realization of fully automated manufacturing.





EVOLUTION TO LIGHTNESS

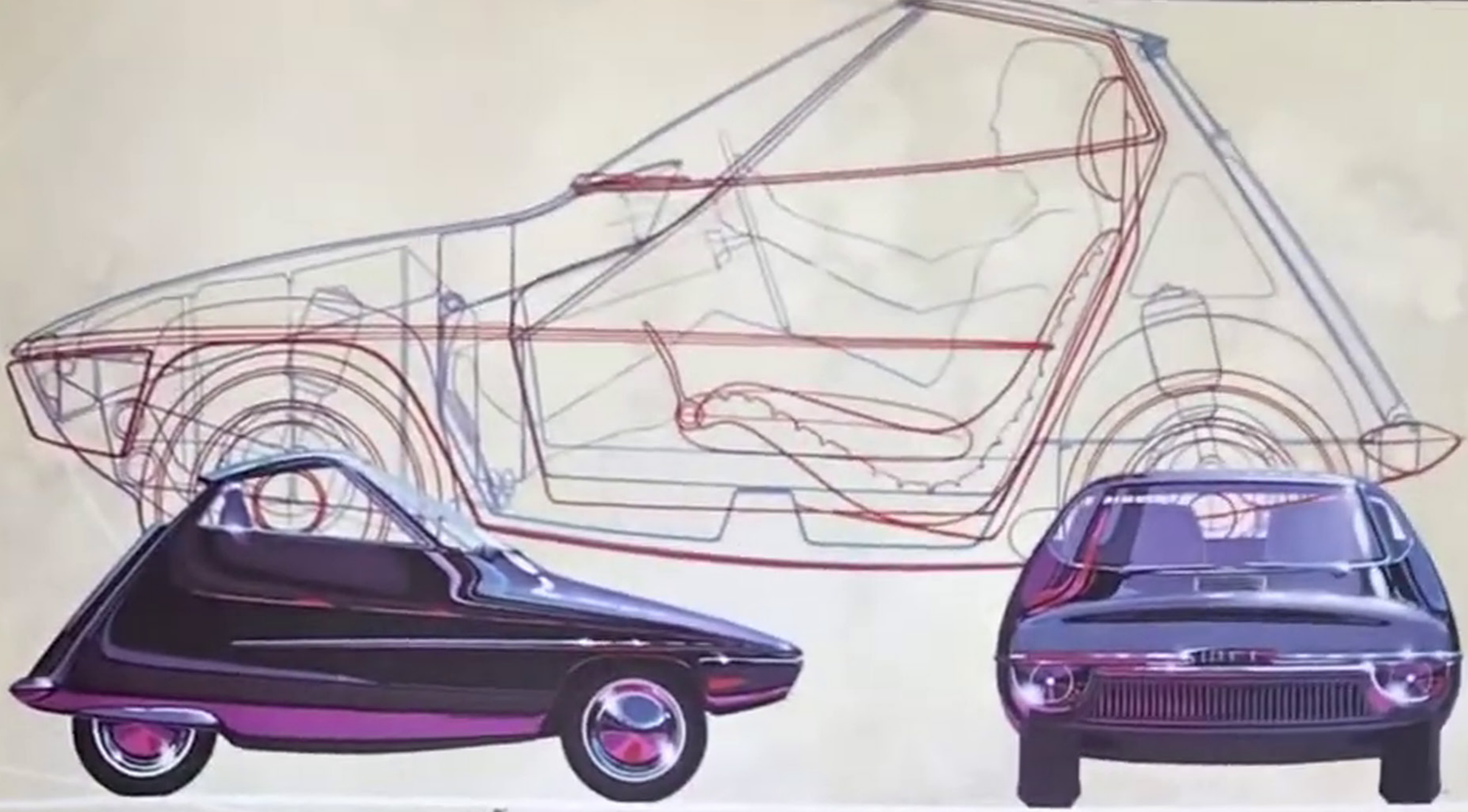
A moving vehicle is subjected to three kinds of resistance: 1. mechanical friction, 2. rolling friction, 3. air drag. At low speeds, friction provides the greatest drain on a vehicle's power plant. At higher speeds, aerodynamic design can materially reduce power requirements, for the greatest part of the engine power is spent moving the air aside and then overcoming the partial vacuum or drag created by the vehicle's passage. This commuter car has a design objective which is to minimize high-speed resistances with a small frontal area and with positive air pressure on the car all the way to the "B" pillar. In this way a path is opened through the almost solid air medium ahead of the vehicle. Rear end design which is also important for favorable forward suction effect can be negated by the drag in the wake of the vehicle. This car's rear end is designed to lower the coefficient of drag by conforming to the space created by the inherent lag in the air medium's rate of closure.

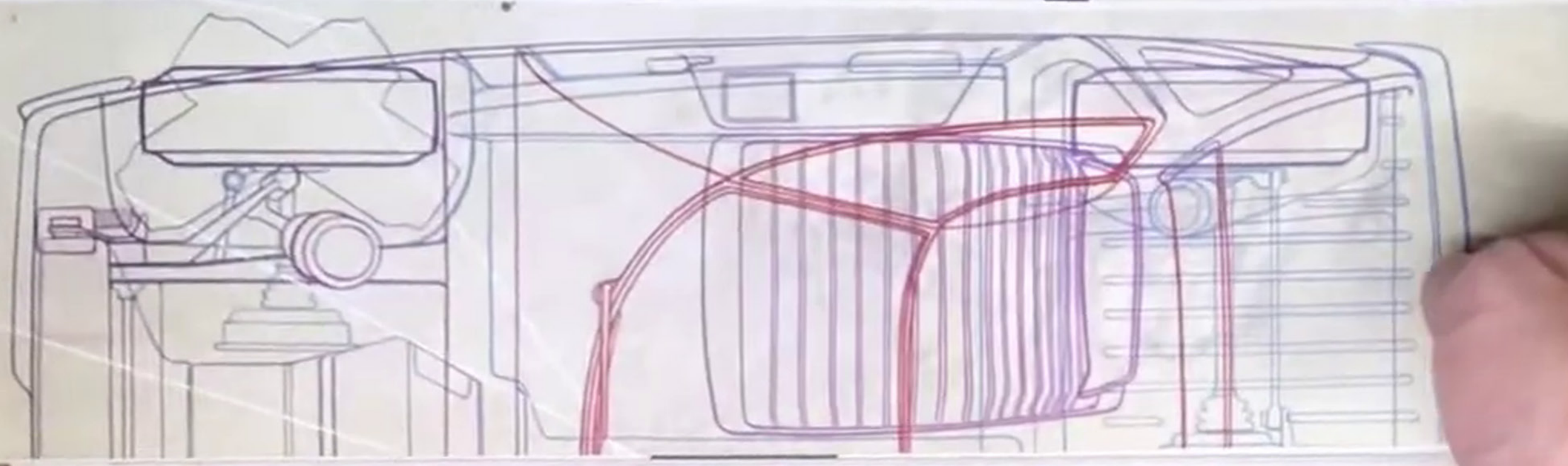
The total package dimensions of this car give the customer more of what is desired: economical, fast and comfortable short-haul transportation with a minimum weight. Headroom in this car is an important measure of comfort. Door cut, entrance space, seat height, legroom, hiproom, steering wheel position and visibility over the hood are more examples of dimensions which contribute to comfort and safety. Design which provides better dimensions results in improved comfort and performance.

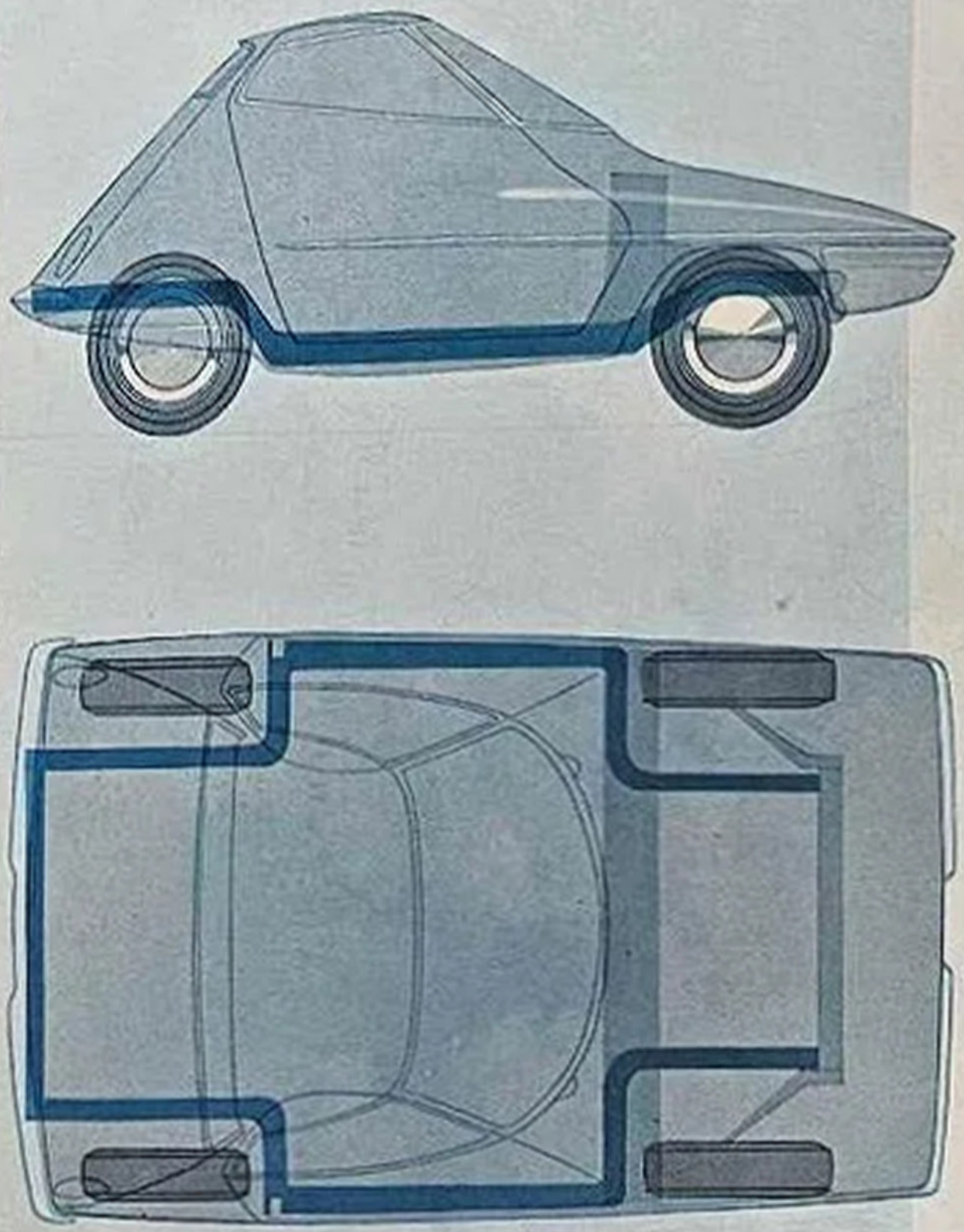
It goes without saying that the functions of propulsion, suspension and braking should be performed by the lightest possible component weights. This is doubly true in such a vehicle as this small, lightweight commuter car. A successful solution here greatly simplifies the packaging problem of the propulsion components and also improves the ride and handling characteristics.

The propulsion package is a constant speed gas turbine engine teamed with a hydrostatic transmission to provide an all-wheel drive. This engine delivers horsepower roughly equal to its weight. It uses neither anti-freeze nor cooling water and it has no transmission gears. Oil consumption is almost zero and it will run on practically any kind of liquid fuel. It starts quickly at very low temperatures and is virtually free of vibration. The advanced type transmission provides infinitely variable forward and reverse speeds. Gear shift lever, clutch, throttle, and brake pedal are eliminated; the transmission is simply a variable displacement hydraulic pump which delivers high pressure oil to radial hydraulic motors on each wheel.

Forward and reverse drive, acceleration and speed are all controlled with one lever which governs the amount and direction of the hydraulic oil flow.







DESIGN IMPROVEMENTS ON OLD SYSTEMS

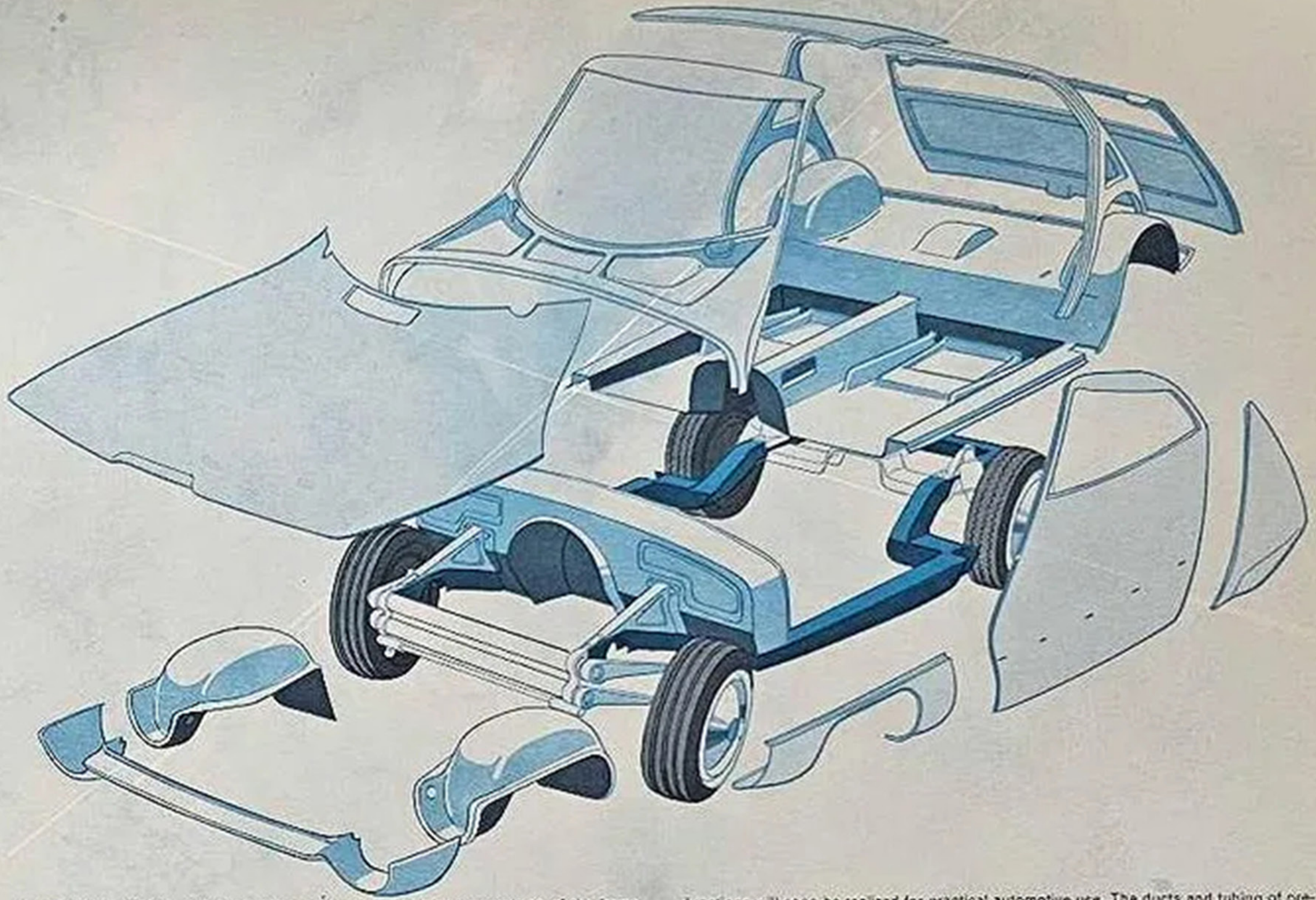
The choice between separate frame and integral frame depends upon such factors as car height, seating dimensions and car type. Comparative structural experience is inconclusive in determining which is superior; each conception has its merits. The relative rate of progress of these two designs within the next few years in the areas of performance, strength, weight, cost and safety will determine the ultimate trend.

Separate frame design is far from obsolescent, especially in wheelbase lengths over 100". As the wheelbase increases, the greater structural requirements either eliminate or considerably diminish the advantages of structure gain or weight reduction which are obtainable with integral frame construction.

Some of the advantages of separate frame design over integral frame design are:

1. Design flexibility over a wide range of models and styling variations.
2. Advanced frame designs which meet the requirements of mechanical improvements and ride advances.
3. Reduction of threshhold step-over areas.
4. Satisfactory exhaust system space requirements.
5. Beam and torsional stiffness which complement the body with high values.
6. Compensation for the loss of effective roof structures.
7. Shortening of body lead time by three to six months.
8. Considerably more margin of error allowable.

A typical frame design advancement is this "wide-hip" frame. It eliminates the X-member and cross-members in the body center section. The function of such members is moved outboard to the rocker panels through the use of efficient structural "torque-boxes." These are located at the four corners where inner and outer frame side rails join. They transfer the body and suspension loads from the narrow front and rear frame sections to the wide, box-section center side rails of the frame. High-Strength, low-alloy steel provides additional strength to these side rails, which are located immediately inboard of the body rocker panel. This allows direct attachment of the body to the side rails through rubber mounts. The cost and weight of body out-rigger brackets are eliminated in this way.



Generally, simplification of body design is a means to an end, regardless of the frame concept used. Here weight savings are achieved by thinner door sections. Garnish moldings are designed as a part of the inner door panels. The fuel tank top and floor pan are part of the same stamping. The reinforced carbon steel, combination instrument panel and cowl crossbody structure carries printed circuits that reduce the amount of wiring connections. With the rapidly advancing trend toward miniaturization bringing full facilities for comfort-conditioning within the car and satisfactory means for traffic signaling outside, it is no longer necessary for windows to open or close. Cellular carbon steel structures in the body panels allow air transfer into or out of the car as desired. More graceful car design lines are now possible since the gas turbine eliminates the chronically troublesome radiator. The engineer's dream of a single fluid for steering, braking and other power functions will soon be realized for practical automotive use. The ducts and tubing of preformed painted carbon steel sheets become a part of the body structure and serve a dual purpose. They conduct the hydraulic fluid and provide greater rigidity to the body shell. In future body designs it will be possible to combine and reduce even more the number of body parts. The art of integrating skin, structural and functional parts will be improved, enabling the engineer to add more functional components to the body. Integration of the entire exhaust system into the body shell is a possibility for the near future. Or, muffler systems may be eliminated entirely when more advanced types of powerplants become available. For the present, the corrosion resisting characteristics of Stainless, galvanized and aluminum coated steels make them especially well suited for muffler and exhaust systems.

IMPROVED SEATS BY DESIGN

This low cost American Steel and Wire carbon steel [illegible] mesh spring base, which is imbedded integrally with [illegible] provides desirable supplementary springing. This [illegible] helps offset the return rate limitations of foam. This [illegible] be easily adapted for a heated or air conditioned [illegible] addition of perforations to the upholstery surface.

Today, appearance design in automotive seats is highly important from a stylist's viewpoint. But these new designs are useless if they are not combined with practical mechanical know-how and understanding of materials and techniques so the seats can be developed and refined according to their basic utilitarian function. Studies have shown that seats must have a pleasing appearance and they must provide real comfort and security as well. Spring design and material developments now make it possible to build seat forms that were never practical before. Six design objectives can be set:

1. Improve seating comfort through design. 2. Reduce the size and seat complexity to increase effective interior space. 3. Increase seat construction simplicity. 4. Reduce manufacturing costs.

For the driver to operate his vehicle efficiently he must feel [illegible]. The driver's principal weight is generally on the two bony points of [illegible] the rear half of the seat cushion supports most of the driver [illegible] earing support must be greater. A lesser part of the driver's [illegible] thighs. A support at this seat area which is too firm results [illegible] on the large blood vessels under the thighs. A minimum [illegible] this pressure over the front half of the seat cushion. This [illegible] takes the driver's leg weight. Adjustable seat back [illegible] support relationship.

In addition to varying the weight/support as [illegible] both laterally and longitudinally. Deep lateral [illegible] and security than conventional seat designs. The [illegible] support to the driver's complete body. Adjustments [illegible] provide compensation for individual driver [illegible]

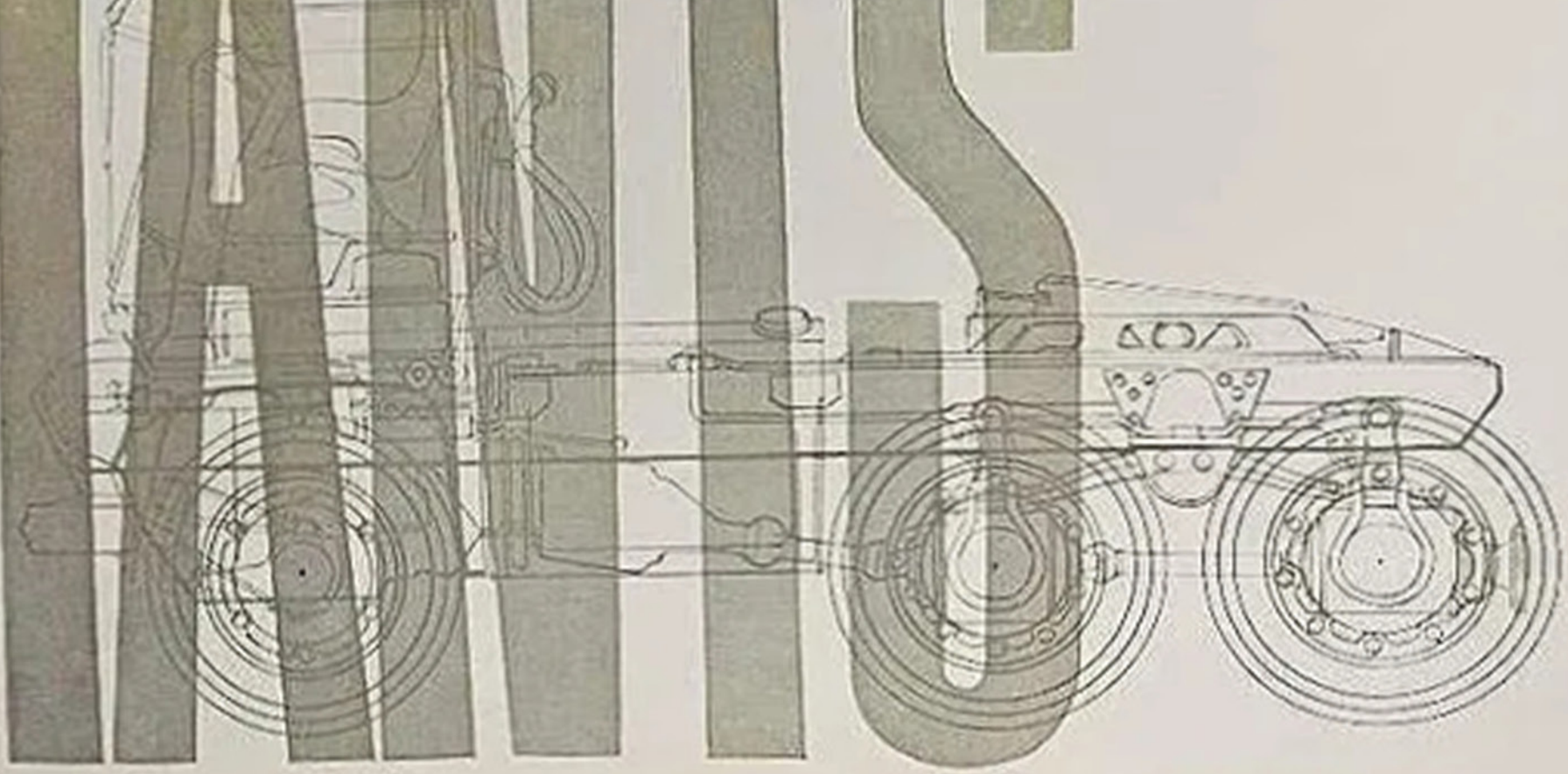
TYPICAL MECHANICAL PROPERTIES

USS CARBON STEEL SHEET AND STRIP

SUMMARY OF

ON THE MOVE...

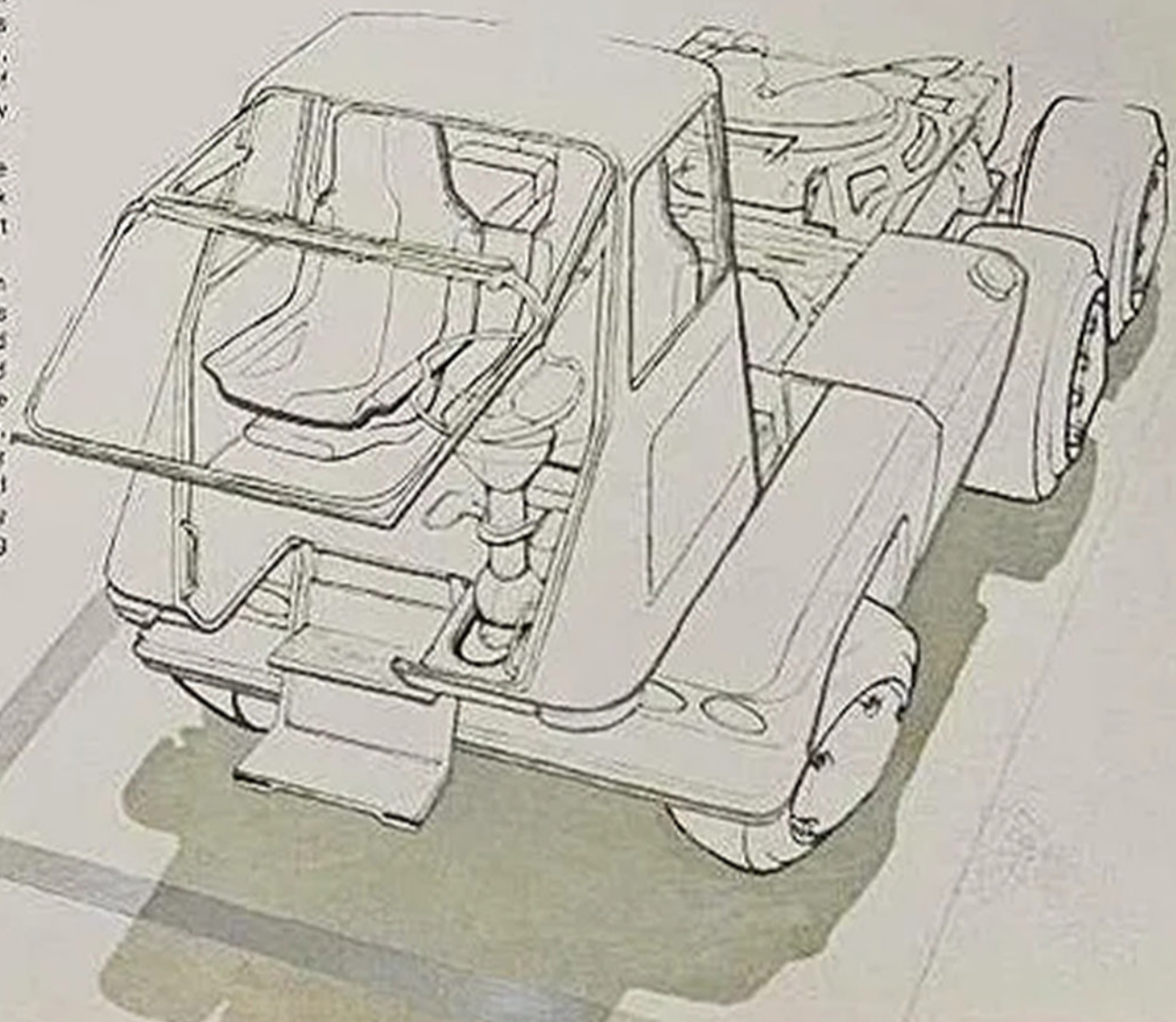
CIAO

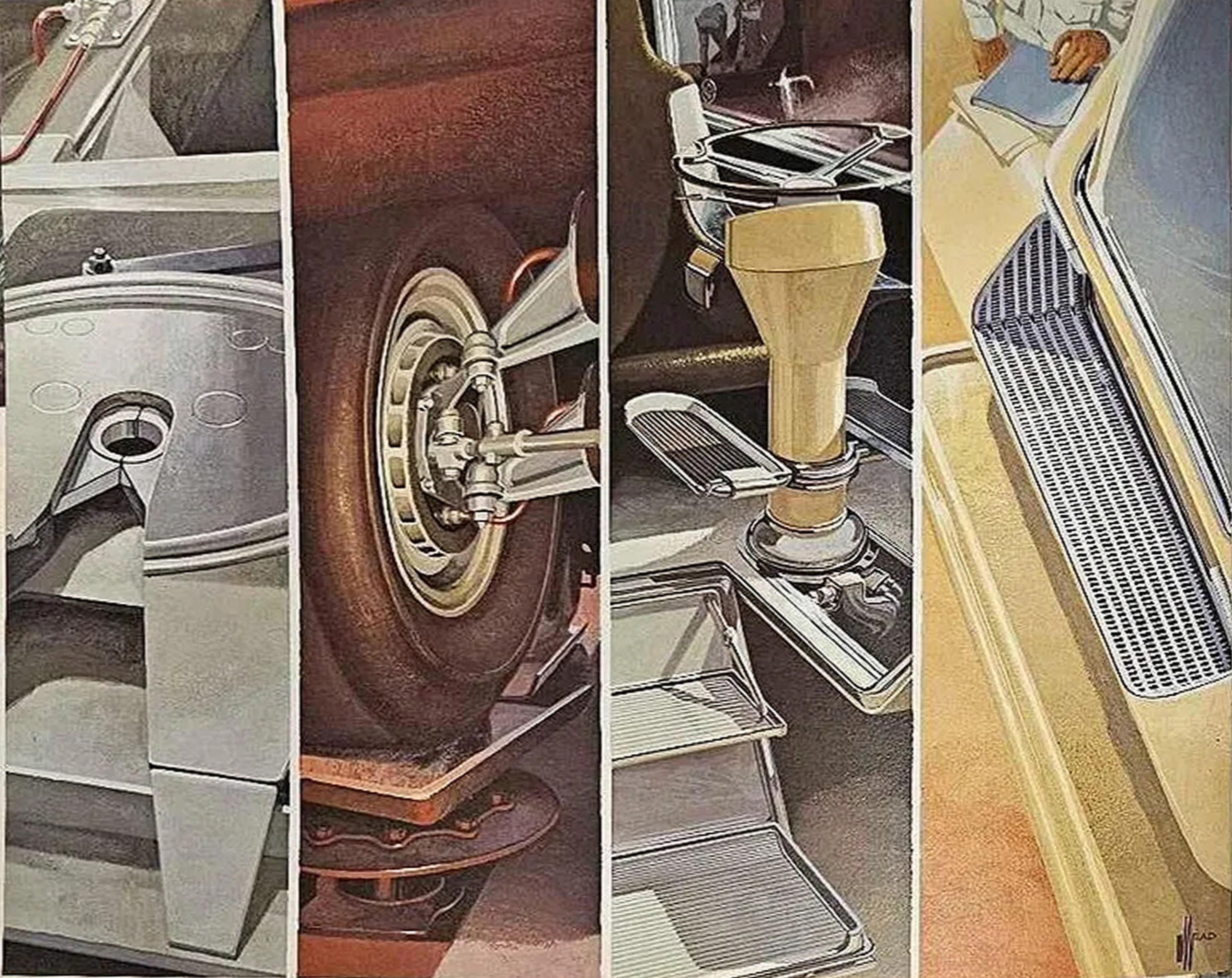


Unlike the first trucks of more than a half century ago, the powerful and sturdy trucks of today are precision tools of transportation. Every conceivable type of hauling job is met by a specialized type of vehicle made possible because of advances in engineering, superior manufacturing methods and new and better steels. Continuing progress of the transportation industry is based on such pioneering and development of new designs, parts, processes and new steels.

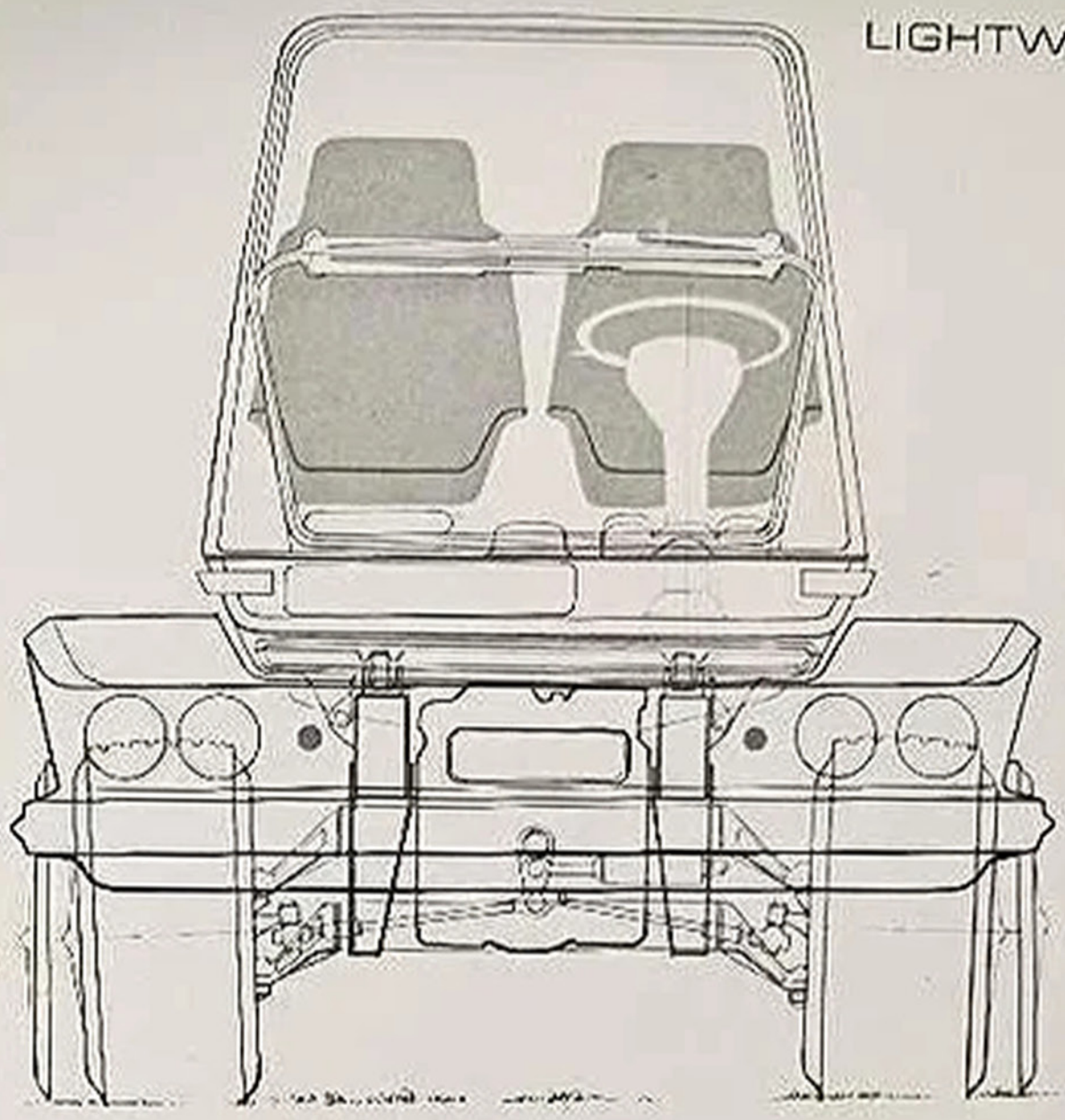
This short-depth cab design permits bigger and heavier payloads in tight squeeze situations. The compact, sliding cab is built of carbon steel. The tractor has set-back front suspension designed to provide tight-turning steerability and improved weight distribution.

Engineering and styling design fits this carbon steel cab to low volume production needs, for it may be built with "one-direction" bends on a press brake. This simplifies tooling and greatly reduces costs. The giant, duplicate-piece, full-wrap windshield provides a safe view of all the road and traffic ahead. The combination windshield and entrance door lifts easily on a steel torsion-spring hinge assembly which combines the functions of a hinge pin and counterbalance. The torsion bar passes through rugged, forged carbon steel bearing and anchor brackets securely attached to the cab. Under constant spring load, even in the down position, the mechanism stays tight, quiet and shake-free. In the driving position the door and cab are secured by a manual safety latch lever. The full height doorway and the slim line roof provide maximum opening height and make entrance or exit easy.





LIGHTWEIGHT DESIGN FOR A HUSKY TRACTOR



For the driver—handling ease, safety and riding comfort. For the mechanic—complete engine and suspension accessibility. For the owner—minimum first cost plus substantially reduced maintenance cost and downtime. This maximum room, short depth cab rolls forward to expose the complete engine and suspension components for service. Flexible cab mountings on USS EX-TEN or USS MAN-TEN steel frame footrails reduce transmission of chassis vibration to the cab. The simple one-piece, cab shell with its double-wall construction and foam insulation takes full advantage of the strength of carbon steel. This construction provides proof against rattles and body wracking and it requires a minimum number of body parts. Embossed thin-skinned body panels, Vinyl Coated steel interior panels, double-walled construction and foamed-in-place insulation in the floor, sides, back and roof provide maximum weight reduction, simplify manufacturing and give a ride which is sound-free, rattle-free and weather tight. Decorative, durable Vinyl Coated steel combines a choice of color, warmth and texture with the strength and inherent fabrication characteristics of steel. In this way interior multi-color styling and inner body shell structure may be obtained with one manufacturing operation.

Galvanized steel headlight cans resist corrosion so bulb changing is still easy after years of truck service.

The independent front wheel suspension is a parallel arm type using heat treated steel torsion bar springs. The front suspension assembly is bolted to the front end of the frame and includes two rigidly joined tubes which carry the torsion bar springs and the upper and lower forged carbon steel parallel arms. Virtually frictionless, the torsion springs flex freely on the smallest bumps and yet have the capacity to absorb the jolts. In severe torture tests and in over-the-road applications steel torsion springs have consistently demonstrated their ability.

1/ The use of USS "T-1" type A constructional alloy steel to fabricate this heavy duty fifth wheel gives the wheel the strength of an exceptionally thick conventional casting, yet it eliminates a major part of the weight. The use of USS "T-1" type A steel and fabricated reinforcing ribs also stops throat bending or spreading. Double-acting cam locks of forged, chrome molybdenum steel encircle the king pin. Pressed, High-Strength, low-alloy steel such as USS EX-TEN or USS TRI-TEN steel pick-up aprons have a wide entrance angle to facilitate trailer pick-up and protect trailer front panels during coupling. **2**/ Steel for such uses as steering linkage and parallel arm type suspensions is improved by forging, since the grain structure of steel is refined and oriented for greater strength in the process. Heat treatment of the forged parts refines the grain structure still further and produces the required mechanical properties. In heat treatment, annealing, normalizing, quenching and tempering all serve the purpose of improving the quality of the steel. Annealing develops the maximum ductility of the steel. Normalizing the as-forged part refines the grain and establishes a more uniform grain size to increase both the toughness and the ductility of the steel. Quenching and tempering refines the grain of steel and also improves its mechanical properties. These processes are all methods of increasing the desirable characteristics of steel in order to combine strength with torsional and shock-resisting properties, a combination important in heavy-duty truck suspension and steering. **3**/ The use of expanded USS Stainless Steel for the entrance/exit steps makes them light in weight and slip proof. Vinyl Coated steel, with its resistance to scuff, wear, abrasion and moisture is especially practical for the interior floor. This durable floor finish eliminates the need for the usual jute pad and rubber mat. Rigidized USS Stainless Steel floor inserts take the beating in the heaviest wear areas. The master control column uses Vinyl Coated steel for its strength and color coordinated styling. The column-contained operating instrument panels are Vinyl Coated steel, used for its anti-glare properties. Aircraft type brake and clutch treadles are mounted on the control column to eliminate the usual toe board holes. Roll-forming the carbon steel treadles and accelerator pedal makes them slip-proof. **4**/ The ability to absorb impact is a first requisite of heavy duty truck bumpers. Since plating quality finish is uncalled for in such truck applications, the advantages of USS EX-TEN steel's strength can be utilized to reduce section thickness and so gain the benefit of weight reduction. Heavy ribbing and U-channel design add strength to this bumper. Rigidly bolted to the frame rail ends, the bumper also serves as an extra stiffening frame cross member. A stamped USS Stainless Steel grille provides ready access to the air intake filter. This self-cleaning, baffle filter, made of carbon steel wire mesh, screens incoming fresh air for the regenerative gas turbine engine.

LIGHTENING THE DEADLOAD — INCREASING THE PAYLOAD

The frame is the backbone of a truck and the durability of the entire rig depends on how well the frame is designed, the materials used and how sturdily it is assembled. Different steels are specified for different frame construction considerations. These range from a [illegible] steel side rail up to single channel rails. The use of USS "T-1" type A steel for "C" channel side rails result in an ideal frame for heavy-duty truck operation. For heavier duty, composite side rails which give maximum relief from full load concentrations may be obtained by using a steel liner liner. This gives greater strength to the side rails. Inverted "L" reinforcing members may be mounted on top of the side rails and extended well beyond the front and rear suspension mounting points. Conventional "L" reinforcements can be welded to the "C" web while hybrid side rails can be fabricated of USS "T-1" type A steel flanges and carbon steel webs. This gives the desirable flange strength and vertical rigidity.

The High-Strength, low-alloy, steel such as USS COR-TEN or USS TRI-TEN steel, box-section front crossmember of this tractor is a fully enclosed steel hat-section. This construction provides exceptional front frame strength and a solid foundation for the forged carbon steel independent suspension. High-Strength, low-alloy steel "K", "Z", inverted "L", I-beam or angle-type cross-members and gussets provide outstanding torsional rigidity plus high load-carrying strength.

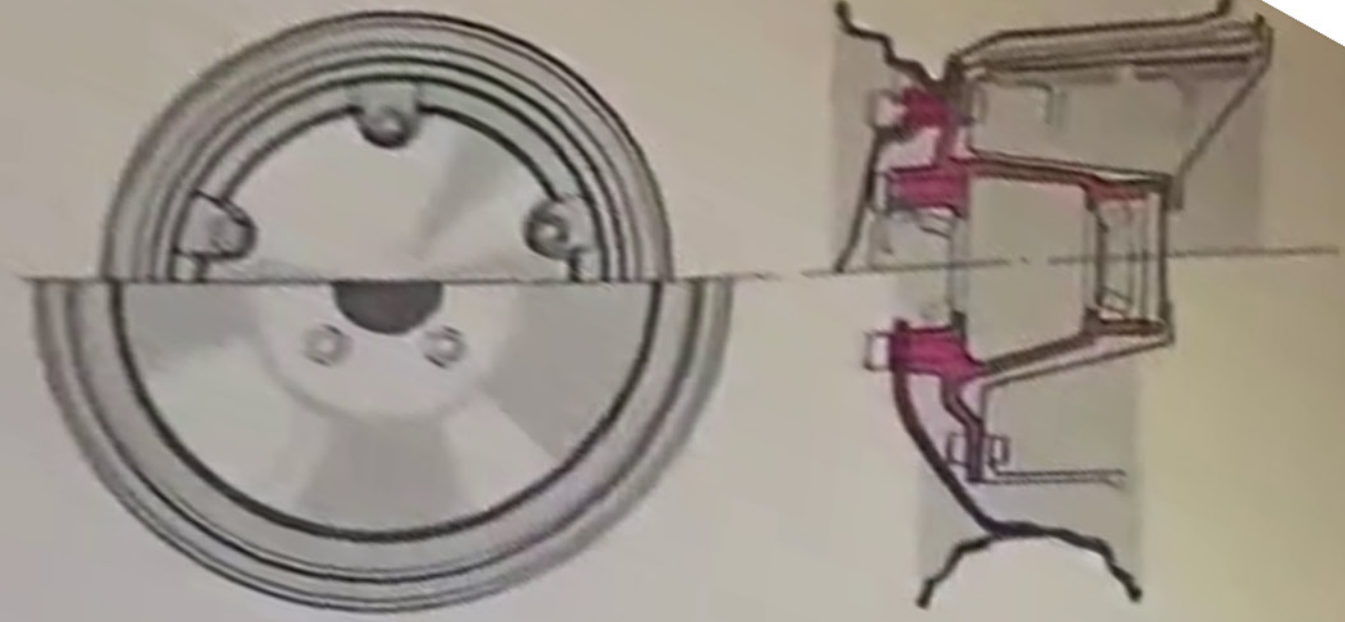
Forged USS "T-1" type A steel rear spring and multi-purpose brackets are securely bolted to the frame side rails with high strength, heat-treated steel bolts and self-locking nuts made of American Steel & Wire AMERLOY steel. Use of this bolted construction permits changes in frame length or ledge position if desired later. When these bolts are tightened to their working load, they stay tight despite vibration and they are resistant to fatigue from constant load reversals. They cut costs and speed up final assembly, for their use in number can be reduced while still obtaining greater joint strength.

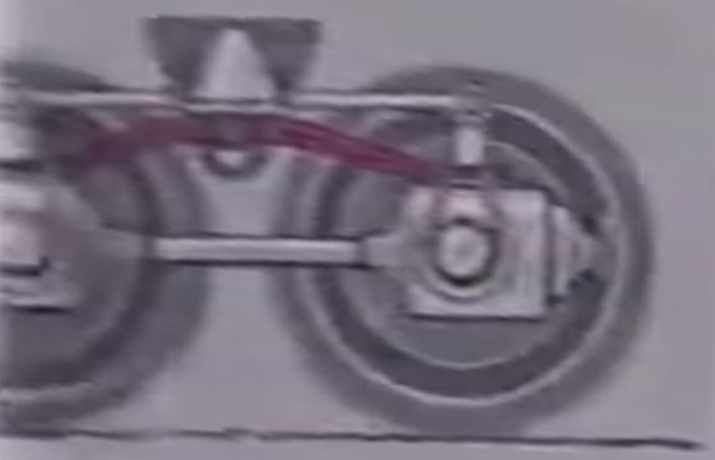
Careful steel selection and imaginative frame design can provide lightweight, tough frames that are stronger and more resilient. Payload and performance are greatly increased since they have all of this strength without unnecessary deadweight.

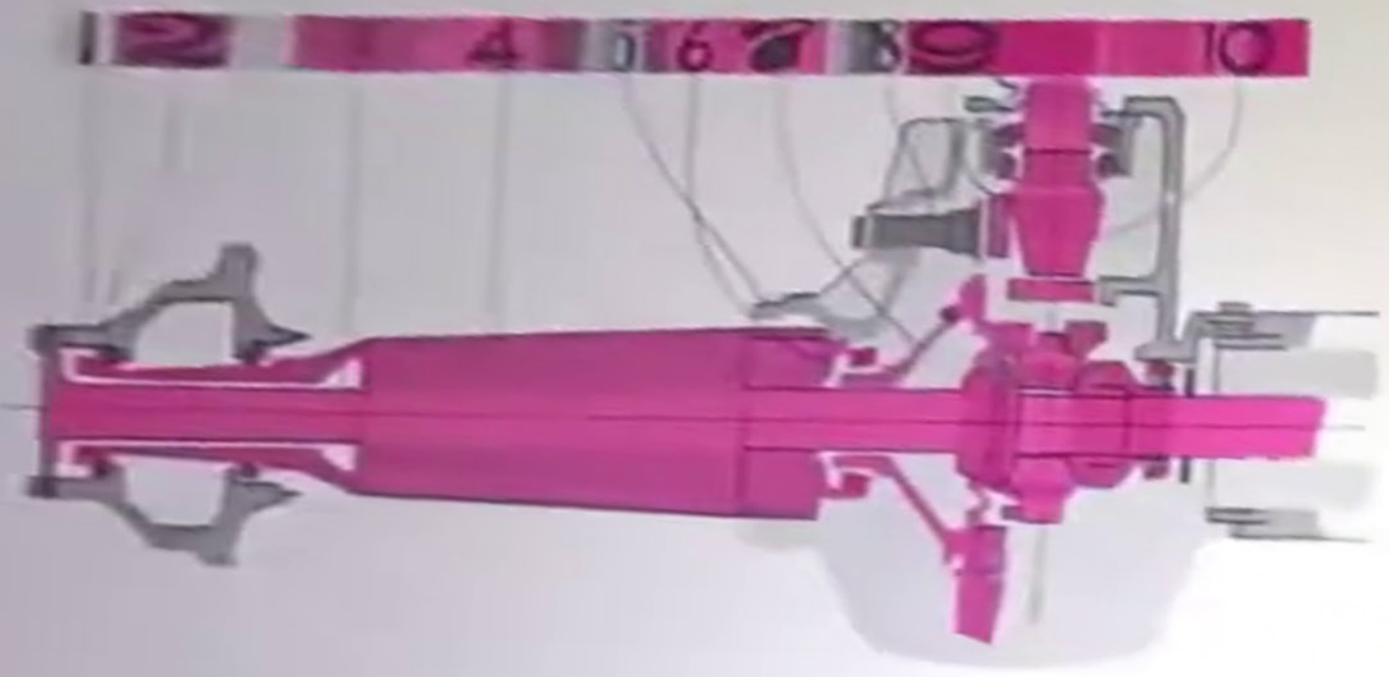
More universal in its applications than the textile tire, the bonded, brass-plated steel cord tire can be used equally well on fronts, drives or on trailer positions on over-the-highway rigs. Great improvements in load carrying qualities are realized from belted, steel cord tires. The American Steel and Wire brass-plated steel tire cord reinforced carcass gives better rubber adhesion than any other product. Added advantages are found in [illegible] resistance to impact, puncturing, bruising and penetration. Lessened rolling resistance decreases fuel costs and since non-slip [illegible] on wet roads tire is greater than that of ordinary tires.

Use of the new low, wide tires provides greater vehicle stability and a smaller turning radius since it permits a wider spring base and wheel-weight. Location of the brakes to the airstream reduces brake fade. Elimination of the extra [illegible] and tires give an obvious weight and cost savings.

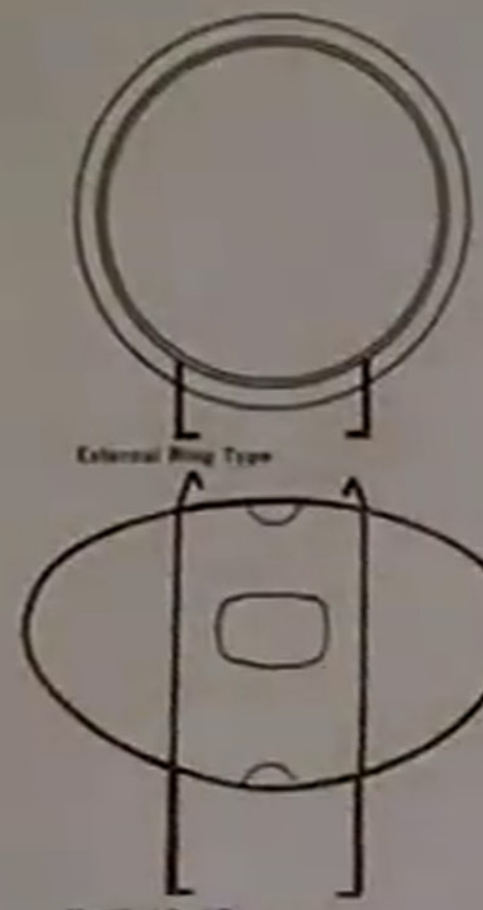
NEW WHEELS FROM THE WHEEL AND TIRE INDUSTRY



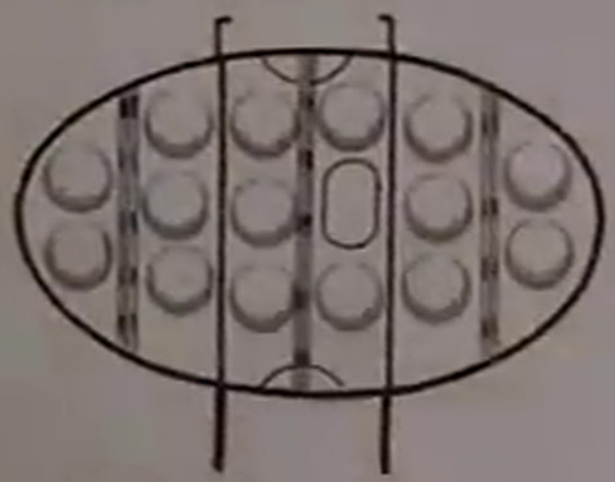




Blimp or Neckdown Type



External Ring Type



Internally Braced Type

MODERN TRAILERS FOR GREATER PAY LOADS

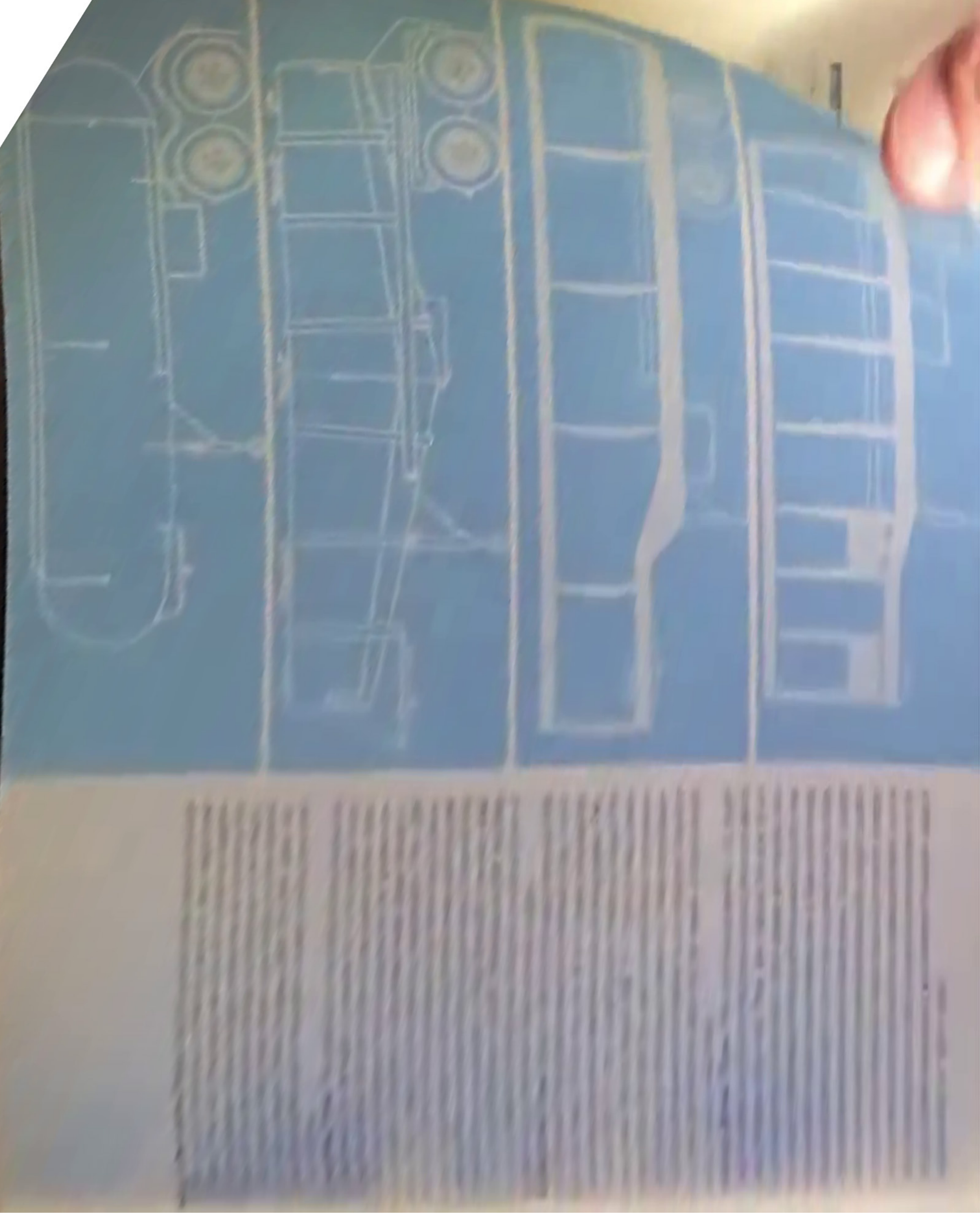
Imaginative design, sound principles and the weight-saving advantage of thinner, but stronger steels are combined to:
Eliminate excessive deadweight without loss of structural strength
Achieve lower overall height and a lower center of gravity
Perform both tank and structural functions
Reduce manufacturing complexities and costs.

Blimp or Neckdown Type. This design simplicity is made possible through the use of USS "T-1" type A constructional alloy steel's great strength. Such fully proved tank-trailers for pressurized liquid cargos comply with highway and Code regulations. External Ring Type. This construction reduces weight by providing the strongest possible shell without the need for internal reinforcing members. This construction also serves to reduce overall height. The absence of weak, flat surfaces in the round, exterior ring shell provides sufficient strength for higher operating pressures and permits a wider range of cargos.

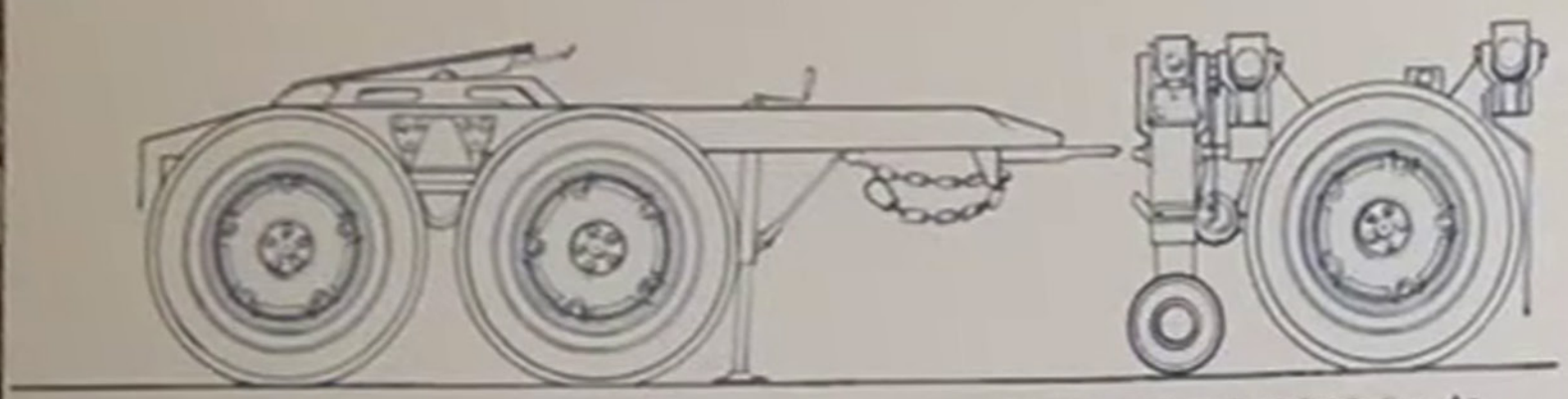
Modified Oval Type. The modified oval design reduces the overall height greatly compared to a round type tank of the same capacity. The center of gravity is lowered too and this greatly increases the road stability of the complete trailer. Finally, this modified oval design provides progressively greater strength toward the tank bottom where the loads are heaviest. This progressive increase in strength toward the tank bottom is partly due to the short radius, round shape of the lower half of the tank. A combination of lighter gages of steels with different strength levels also provides greater strength where it is needed most—at the tank bottom. Baffles and bulkheads are dish-shaped and flanged to add strength to the shell and reduce surging forces on the bulkheads. Openings in the baffles provide complete drainage and a convenient access to each compartment.

Internally Braced Type. Placing special members and reinforcements at high stress areas distributes the stresses evenly, rather than concentrating them. This permits the use of the complete USS Family of Steels: USS "T-1" type A for highly stressed areas; USS COR-TEN for medium stressed areas and USS carbon steels for relatively low stressed areas. Formed, vertical head stiffeners and rugged reinforcing girders over the upper coupler section, transition section and axle assembly distribute concentrated stresses over a wide shell area to assure liquid-tight operation. Dimpled, flanged baffles are reinforced with large wedge-shaped stiffeners to add strength to the shell and to reduce surging forces on the bulkheads. Dimpled, flanged and reinforced bulkheads add strength to the load carrying tank shell and distribute localized stresses over a large shell area. Reinforcing ribs are welded to the longer radius sheets in the bottom shell of the necked-down sections. These reinforcing ribs eliminate buckling due to surging of the liquid and localized kingpin loads.

TANK TRAILERS



A SEMI OR TANDEM TRAILER THROUGH DESIGN FLEXIBILITY



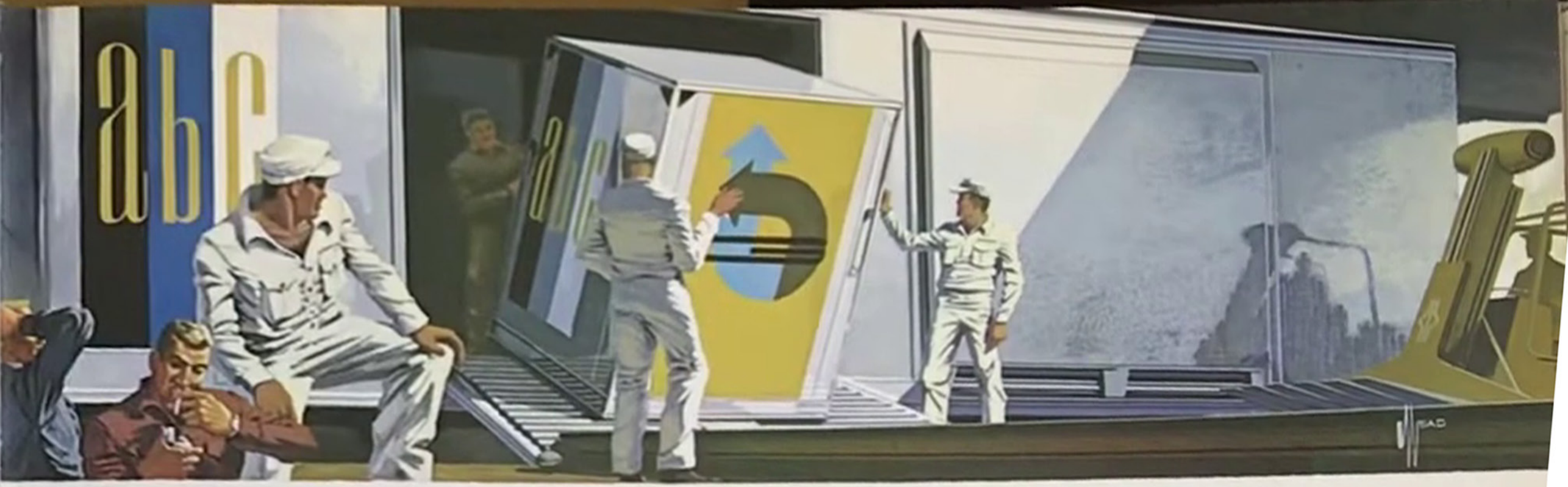
TRAILER DESIGN KEEPS PACE WITH PROGRESS

This tandem axle dolly provides a maximum safe payload distribution. An "A" type combination frame and drawbar is hybrid designed of tough, USS "T-1" type A steel for the flanges and carbon steel for the webs. Weight-saving tapered leaf springs reduce deadweight. The lightweight but heavy duty fifth wheel is USS "T-1" type A steel. The forged USS "T-1" steel pintle hook is rubber mounted and air cushioned so it absorbs pulling and braking shocks.

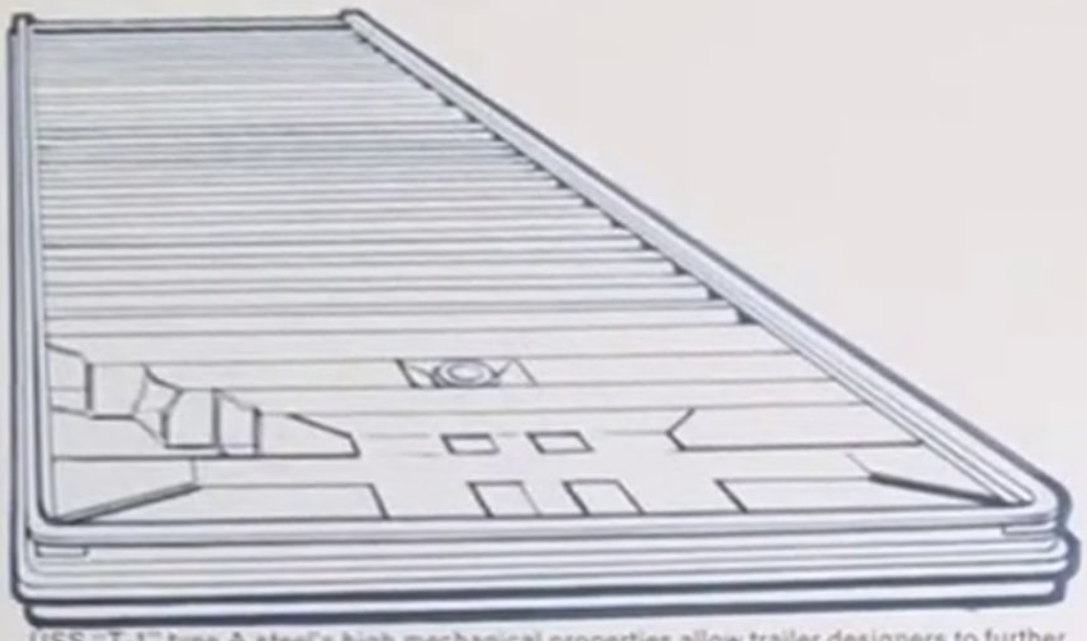
This complete bogie—axle, springs, brakes and landing gear—is shiftable on and removable from the trailer bottom rails. It can be used as a single axle, equalized tandem or triple axle suspension. Correctly positioning the bogie and landing gear on the bottom rails is a one man operation, after which the bogie is pinned and positively clamped.

Dry freight and food hauling problems call for especially designed trailers that meet as many of the operators' varying needs as possible. Advanced engineering and manufacturing know-how, plus versatile new steels, provide practical solutions to these van and reefer type trailer problems. Today, the engineers' efforts show continual advancements in the use of lighter gage steel, elimination of excess weight without altering structural strength, and achievement of a lower center of gravity and lower overall height. He looks to lighter, more versatile suspensions that will permit easy conversion from semi- to tandem trailer for "double bottom" operation. Or, he may seek removable and shiftable bogies that permit better weight distribution to meet highway restrictions. He advocates new constructions that provide strength, greater payload capacity and allow a big cut in trailer weight. As the engineer achieves these ends, he adds revenue producing payload.

Multi-stops and short haul deliveries often sap trailer operation profits. So, the engineer designs to allow the driver to load or unload at final or intermediate destinations as he chooses, regardless of the cargo loading. And, to protect the cargo in transit, the engineer designs strength and ruggedness into the trailer body, thus enabling it to withstand highly concentrated load stresses, impact forces and torsional wracking. To meet the increasingly severe demands on trailer design, the engineer turns to the new carbon, High-Strength, low-alloy steels or High-Strength heat treated constructional alloy steels or Stainless Steels.

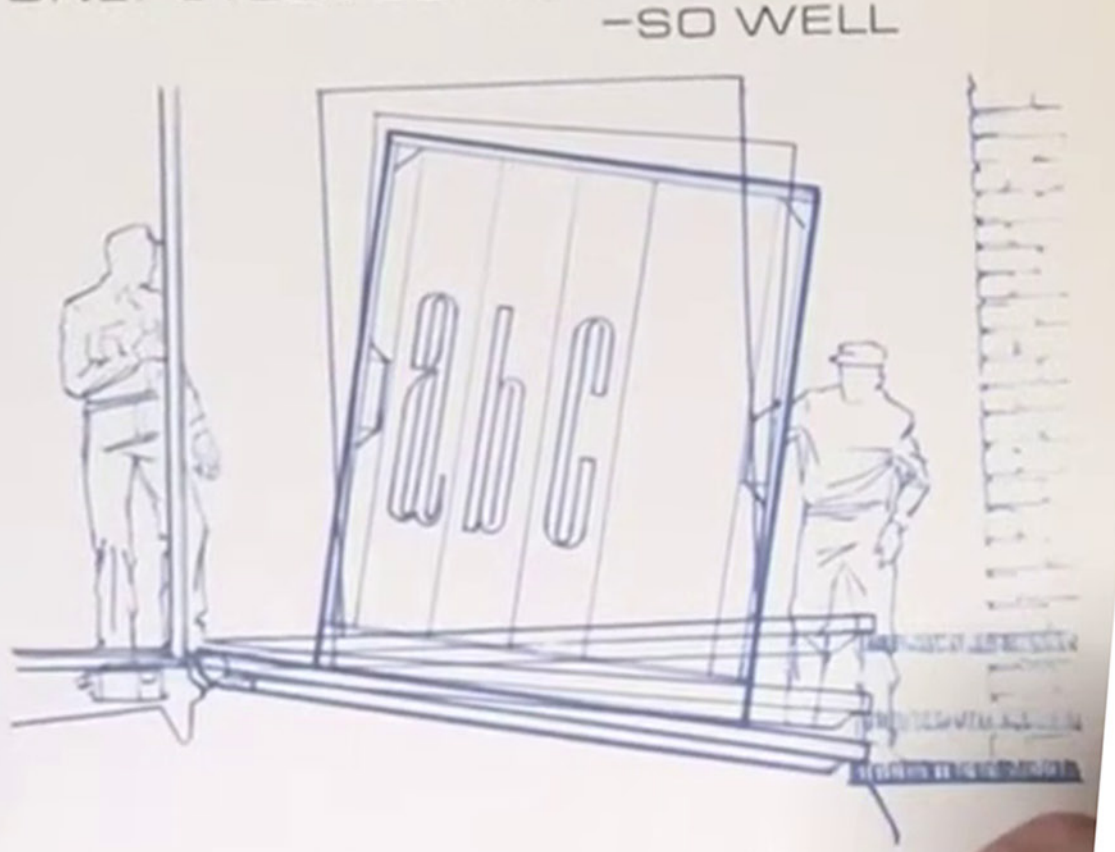


REDUCED WEIGHT AND REDUCED COSTS WITH HIGHER STRENGTH STEELS



USS "T-1" type A steel's high mechanical properties allow trailer designers to further reduce the weight of trailer understructures. The USS "T-1" type A steel suspension members are main load bearing members. USS COR-TEN or USS TRI-TEN steel outriggers and cross members are placed on 12" centers between the two main outer rails. Cross member ends are welded to the USS TRI-TEN steel outer rails which also act as sturdy rub rails and longitudinal load bearing members. USS TRI-TEN steel has good shock resistance even at low temperatures, and a high endurance limit. The rugged upper coupler is a sandwich grid structure of rectangular tubing made of USS "T-1" type A steel. A full-width USS MAN-TEN or USS TRI-TEN steel pick-up plate on the underside of the coupler structure prevents trailer damage during coupling.

ONLY STEEL SERVES SO LONG –SO WELL



If the driver is to be able to load or unload at intermediate or final destin he chooses, regardless of the cargo loading, every inch of cube must accessible. Rear, curb or roadside doors divide the van into easy-to-r that permit fast loading and unloading. Deep USS TRI-TEN steel outer nate side door trusses and give door location flexibility. The High-Streng steel top rails permit big side openings that are free of gussets which m loading.

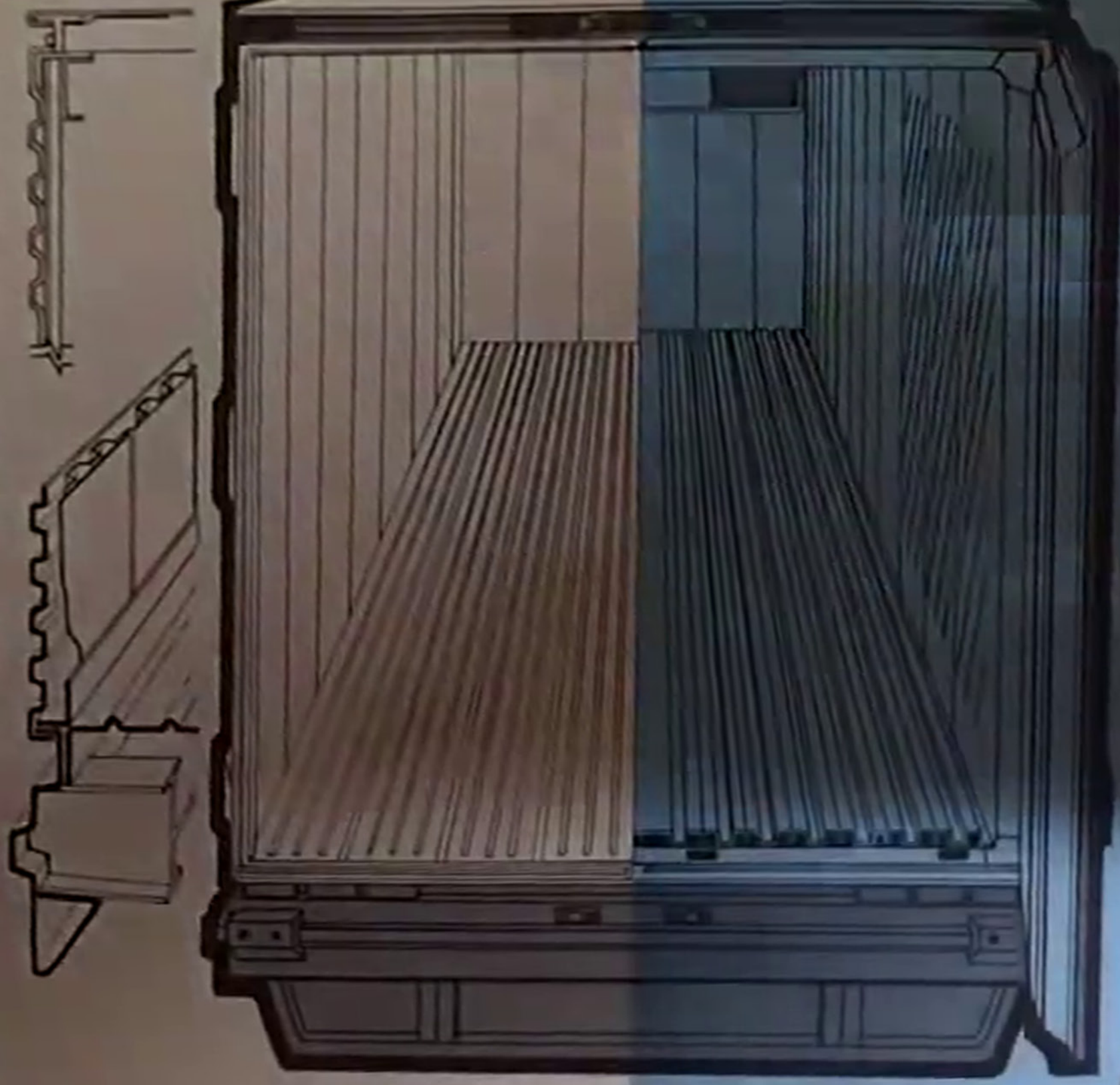
STRENGTH + LOW COST + LOW WEIGHT—
FOR EVERY TYPE TRAILER—

Bigger payloads can be carried and they can be loaded and unloaded more easily because engineering design, combined with unique applications of the right steels, provides more useful van width, length and height plus higher and wider door openings. The unique construction of roller, sidewalls, doors and roofs allows them to be thin, yet gives exceptional ruggedness, rigidity and strength. The use of USS High-Strength, low-alloy steel results in long life, shock resistance and a high strength-to-weight ratio. These steels have up to 4 to 6 times the atmospheric corrosion resistance of carbon steel. The strongest possible construction for the weight is obtained by designing every part of the van's structure to add strength, to improve rigidity and to increase payload capacity.

Integral corrugations on 2-inch centers in the roof, nose and side panels provide longitudinal rigidity. Low depth, fish-shaped roof bows provide cross-body strength and extra cradle height. Exceptionally strong and durable hat-shaped side posts insure vertical stability. Welding every corrugation to every side post makes a virtual box section of every corrugation. Constructed in this manner, these box sections can withstand wracking loads and stresses from any direction. Permanently fastening these parts by welding gives a tremendous torsional strength without increase in weight. A modified I-beam, USS COR-TEN or USS EX-TEN steel rolled section quarter panel welded to a deep USS TRI-TEN or USS EX-TEN steel top rail running the full length of the trailer provides the body strength that permits big side openings.

The wide roof bows are welded to the outermost inner flanges of the quarter panel I-beam. The roof bows and side posts give solid roof and side support for the full length of the trailer. Welding and rolling the roof panel over and under the top outer flange of the quarter panel ties the roof and side panels into one strong, leak-proof structure.

Each side post is welded to the USS TRI-TEN steel outer rail while the lower edge of the corrugated panel is rolled around, under and welded to the upper flange of the outer rail. This heavy section USS TRI-TEN steel outer rail gives rigidity to the trailer sides. The USS "T-1" type A steel rear frame cross member supports the ICC bumper. The roll-formed steel dry freight floors are welded to the wide-flange cross members for still greater frame strength and torsional rigidity.

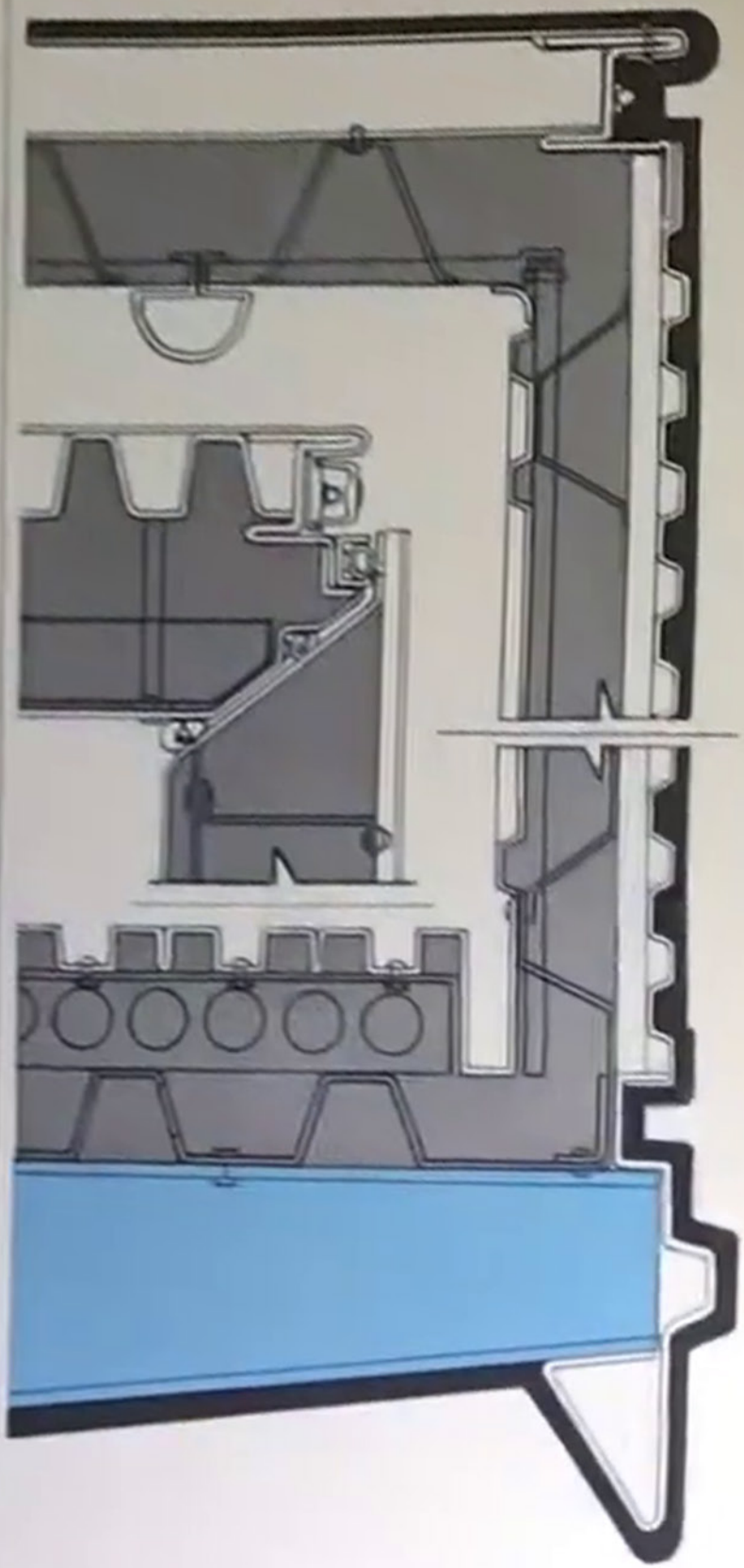


USS COR-TEN STEEL VAN TRAILER

STAINLESS STEEL REFRIGERATOR TRAILER

- Riveting, caulking and welding the corrugated USS Stainless Steel roof panel over and under the quarter panel flange seals out air and moisture. Such construction minimizes removal air filtering through tiny crevices in the outer shell.
- Extra wide, double hat-section Stainless Steel roof bows are securely welded to the corrugated panel flanges and to each roof corrugation. This provides cross-body and torsional strength.
- Heavy gage, rib-formed Stainless Steel quarter panels provide structural strength for the side and end walls. The lower quarter panel flange laps and air-weather seals the corrugated Stainless Steel outer panel.
- Corrugations in the inner liner permit cold air movement around closely packed cargo.
- The Stainless Steel one outer shell has ½" corrugations on 2" centers which are welded to Stainless Steel sidewall posts at every corrugation. This construction gives exceptional strength in every direction to the outer shell. Only Stainless Steel has the strength to permit such [illegible] which will give trouble-free service for the life of the trailer.
- "V"-shut spacers separate and insulate the inner sidewall posts and cargo liner. A one inch [illegible] prevents air from entering cavity and crevice of the complete [illegible] floor, roof and sides. This barrier is thus completely [illegible] moisture and heat penetration.
- Corrugated, galvanized steel sub-floor spacers are screw fastened to the inner pan and frame cross members. Different screws fasten the cargo liner to the sub-floor. In this way there is [illegible] metal fastening and consequent cooling loss.
- The USS Stainless Steel [illegible] liner facilitates cleaning and also serves as a base scuff plate.
- The clear Stainless Steel cargo floor provides fork and lift air circulation. Welding is [illegible] one piece eliminates joint leaks and waterproofs the floor for the trailer's life.
- Stainless Steel inner floor "Z"-beam cross members are placed on 12" centers and screw fastened to plastic sub-floor spacers.
- 180° molded lights are protected from impact by the deep quarter panel flanges.
- Double rail-section roof bows provide great cross-body roof strength without penalizing inside height.
- Three-seal, compression lockbar doors have full contact all around. This gives full insulation that is effective at high or low temperatures.
- The foam filled door provides thermal insulation.
- Corrugated door inner liner provides the structural strength to keep the door aligned and sealed tightly. Foamed-in-place insulation bonds the door into an integral one-piece [illegible].
- [illegible] door spacer provides structural alignment without permitting [illegible] transmittal of heat to the cargo liner.
- Stainless Steel floor skin is screw fastened to the inner frame and cross members.
- USS "T-H" type A steel serves as a base for weld attaching the frame cross members.

Reefer trailers, subjected to refrigeration's continuous drying and wetting processes, are increasingly expected to meet rigorous requirements of maintaining low temperatures in transit. Stainless steel's qualities of corrosion resistance, strength and fabricability enable designers to meet these requirements with satisfactory, airtight, lifetime trailers. Because of these qualities the thinnest shelled, greatest cube and strongest reefer trailers are built with stainless steel.



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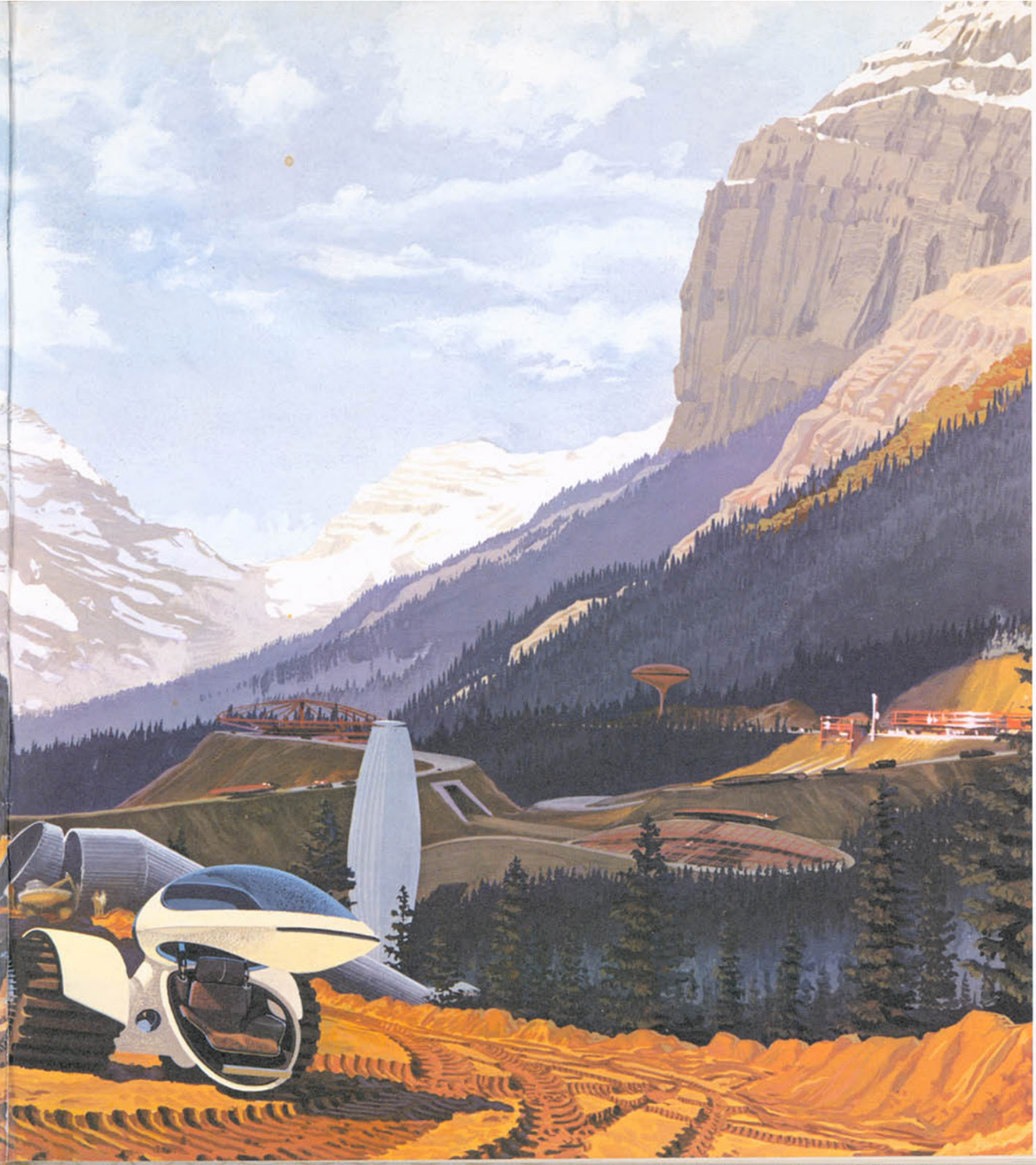


DESIGNED AND BUILT TO TAKE SHOCK, IMPACT AND ABRASIVE FORCES

Fast handling of production dirtmoving is necessary on big yardage, time-measured jobs today. Earthmoving with self-propelled scrapers takes raw power: power to pack in heaped capacity payloads rapidly regardless of how tough and sticky the material; power to high-ball up and out of steep cuts; power to accelerate quickly with a full load, cycle fast and return at top speed. But, important as power alone is, it is only one factor in determining what the scraper will do. The power-to-weight factor is a most important factor to consider. As the percentage of deadweight drops the higher the percentage of payweight rises. Efficiency can be greatly improved by decreasing the scraper deadweight and thereby improving the power-to-weight ratio so that more dirt and less scraper weight is being moved. Decreasing scraper weight can be accomplished in two ways: by improving the design, and thereby the efficiency, of the scraper, and by using selected steels to meet the rigid demands of earthmoving jobs.

The whole family of USS steels is available to meet the demanding requirements of improved scraper designs. These steels range from 30,000 psi to 100,000 psi yield strength. Each fills a particular need, such as improved strength, elevated temperature properties, toughness, corrosion and abrasion resistance, fabricability or other specific requirements.

Of these steels, ASTM A 36 fills the need for a higher yield point carbon steel in plates and shapes at a minimum cost. The High-Strength, low-alloy steels, such as USS COR-TEN and USS TRI-TEN steels, have yield points at the 50,000 psi level and offer better atmospheric corrosion resistance. USS "T-1" and "T-1" type A constructional alloy steels have 100,000 psi minimum yield strength and far greater atmospheric corrosion resistance than carbon steel. Compared to carbon steel, USS "T-1" steel has four to six times greater atmospheric corrosion resistance than structural carbon steel and "T-1" type A steel has twice the atmospheric corrosion resistance. And despite their high strength, they can be formed and welded. All of these new steels are now being applied in the design of stronger yet lighter vehicles and off-the-road equipment. For example, careful application of combinations of such steels for frame members results in weight savings over previous designs. Truck, trailer and off-the-road equipment designs use this concept of materials combinations.

SELECTED STEELS MEET THE RIGID DEMANDS

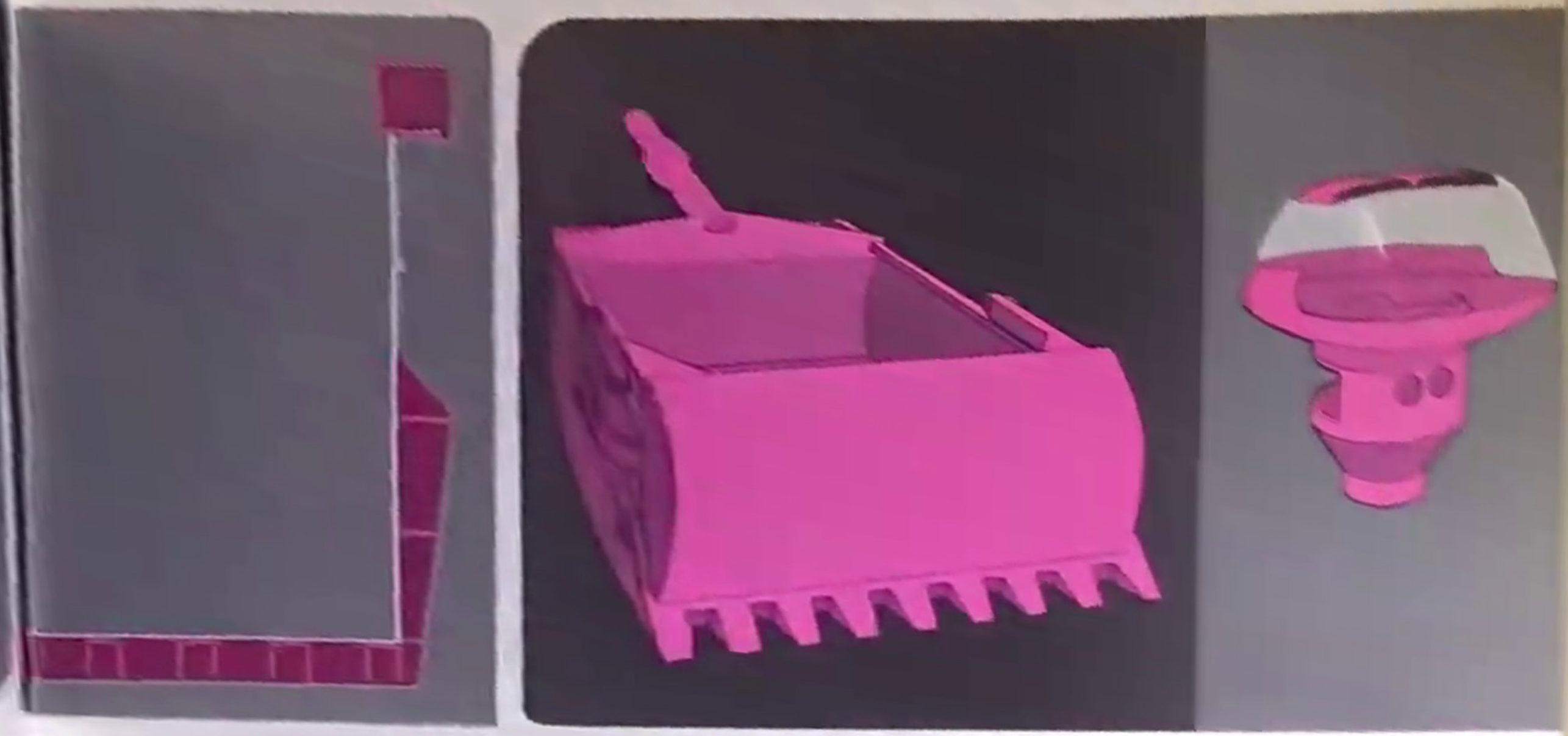
The driver's full view cockpit is the highest part of the earthmover. This design, plus the fact that there are no conventional exhaust stacks, gives him unobstructed vision in all directions. He can see the haul road ahead and he can just as easily watch his ground plate, while finishing a grade or burdling up his load.

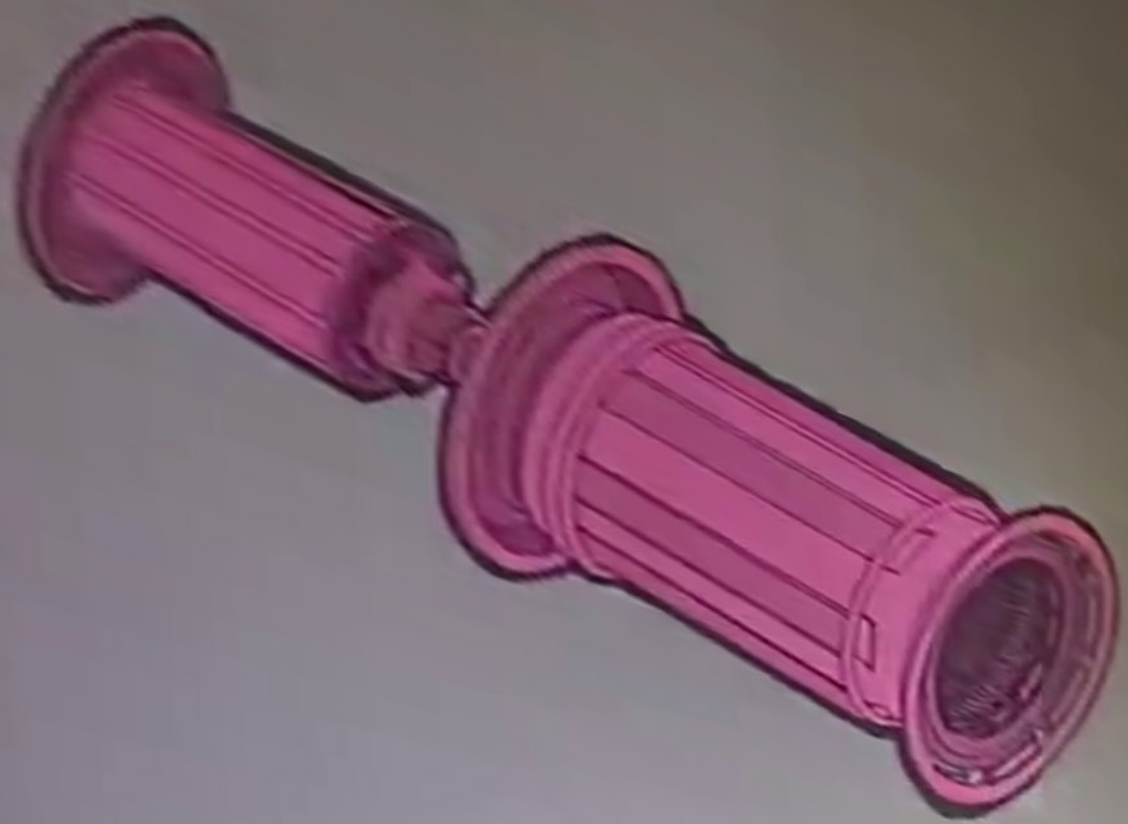
The driver's 4-way adjustable seat is located slightly to left of center. The right-hand tubular carbon steel lever controls all braking, accelerating and steering functions. Rearward movement applies braking; forward controls acceleration; left or right controls steering. The left-hand tubular carbon steel lever controls the bowl position, apron and tailgate jacks. Both levers are spring loaded and damped so they return automatically to neutral positions. The switches and instruments for the twin engines, generators, and hydraulic pumps are cluster mounted on the non-glare Vinyl Coated steel instrument panels.

Twin engines drive the electrical generators and hydraulic pumps and provide mechanical power through a short-coupled drive-train to the four rear wheels. Front wheel drive is direct, with electric motors in each wheel. This eliminates the long shafts, gearing and complex linkages which would otherwise be required. Flexible American Steel and Wire ARMORLOKT electrical cables carry the current through the box-section, octet truss frame members to motors mounted on the front axle. These same box-section frame members also provide protective channels for air and hydraulic lines. All line connections—air, electrical and hydraulic—are made with quick-disconnect jacks that are readily accessible through service doors in the frame.

The slightly curved, double-sheeted bowl bottom lessens loading resistance and aids the rolling dirt action that gives heaped capacity loads. In the haul position the lowest point of the bowl leaves plenty of ground clearance for soft going. The clean, smooth underside of the bowl prevents wasted power in pulling through sticky muck. Controlled hydraulic down pressure on the cutting edges of the USS "T-1" steel ground plate assures quick penetration of tough materials.

The double-acting hydraulic jack cylinders for bowl control and dirt ejection are made of USS NATIONAL cold drawn carbon steel mechanical tubing, precision controlled for wall thickness. The exacting O.D. and I.D. tolerances, plus the uniform concentricity of this tubing, provide finished jack cylinder parts without material wasting or costly machining. The hardened, centerless ground, chrome plated piston shafts prevent rusting, peeling and denting. These shafts are made from carbon steel, cold finished bars which are straight, hard, free of nicks and scratches. This assures a leak-free hydraulic cylinder packing.





PERMEABLE STEELS FOR QUIET PO

MECHANICAL PROPERTIES

USS COR-TEN STEEL

	Thickness Ranges	
	1½ in. and under	Over 1½ in.
Yield Point, min. psi	50,000	46,000
Tensile Strength, min. psi	70,000	67,000
Elong. in 2 in., min. per cent	22	24
Elong. in 8 in., min. per cent (0.180 in. and heavier)	18	19
Cold Bend (180° specimen bend)	½" & under D=1t Over ½" to 1" D=1½t Over 1" to 1½" D=2t	Over 1½" to 2" D=2½t Over 2" D=3t

Mechanical properties are applicable to all processes normally used to produce commercial plate, sheet and strip. Tensile strength requirements will be reduced by 5,000 psi for material over 4 in. in thickness. Bend tests are not required for plates over 1½ in. in thickness.

USS "T-1" TYPE A STEEL

	Thickness Ranges	
	½" to ¾", incl.	Over ¾" to 1", incl.
Yield Strength, Ext. under load (min)	100,000 psi	100,000 psi
Tensile Strength	115,000/135,000 psi	115,000/135,000 psi
Elongation in 2", % (min)	18	16
Reduction of Area, % (min)	40	50
Longitudinal and Transverse Charpy Keyhole Impact Values (ASTM Procedure) (min)	15 ft. lbs. at −50°F	15 ft. lbs. at −50°F

For improved weldability and impact properties, USS "T-1" Type A Steel may be ordered to a maximum carbon of .22%, in which case all other mechanical properties are the same.

USS MAN-TEN STEEL

	Thickness Ranges		
	14 Ga. to ½" incl.	Over ½" to 1½" incl.	Over 1½" to 3" incl.
Yield Point, Min., Psi	50,000	45,000	40,000
Tensile Strength, Min., Psi	75,000	70,000	65,000
Elong. in 8", Min., Per Cent*	18	19	19
Elong. in 2", Min., Per Cent	20		22
Cold Bend—180°	D=1T	D=2T	D=3T

*The minimum yield point and tensile strength requirements will be reduced by 5,000 psi when annealing or normalizing is specified, or when formed hot or cold.
*For all practical weight sheet and strip.

USS EX-TEN STEEL

	EX-TEN 45 Plates, Bars, Structurals, Bar Shapes to ½" incl., HR Sheets, HB Strip, CR Sheets	EX-TEN 50 Plates, Bars, Structurals, Bar Shapes to ½" incl., HR Sheets, HB Strip, CR Sheets	EX-TEN 55 Plates to ½" incl., HB Sheets, HR Strip	EX-TEN 60 Plates to ½" incl., HB Sheets, HR Strip
Yield Point, psi Min.	45,000	50,000	55,000	60,000
Tensile Strength, psi Min.	60,000	65,000	70,000	75,000
Elongation, Min.				
Sheets & Strip % in 2"	25	22	20	18
Other Products % in 8"	19	18	17	16
Cold Bend (Specimen Bend)				
Sheets & Strip	Flat	D=1T	D=1½T	D=2T
Other Products	D=1T	D=1T	D=1½T	D=2T

USS TRI-TEN STEEL

	*Sheets, Strip and Light Plate	Thickness Ranges		
		Plates, Structurals, CB's and Bars**		
		¾" and under	Over ¾ to 1½" incl.	Over 1½ to 4" incl.
Yield Point, min. psi	45,000	50,000	46,000	42,000
Tensile Strength, min. psi	60,000	70,000	67,000	63,000
Elong. in 8 in., min. %	19	18	19	19
Elong. in 2 in., min. %	25	—	—	24
180° Cold Bend (Specimen Bend)	(See below)	D=1t	Over ¾ to 1" D=1½t Over 1 to 1½" D=2t	Over 1½ to 2" D=2½t Over 2 to 4" D=3t
Sheets and Strip	Flat			
Light Plate	D=1t			

*When no value shown for 'A' and units are requested for service with bending or when bend on sheet or strip wide, the ductility properties of the sheet and strip grade will apply.

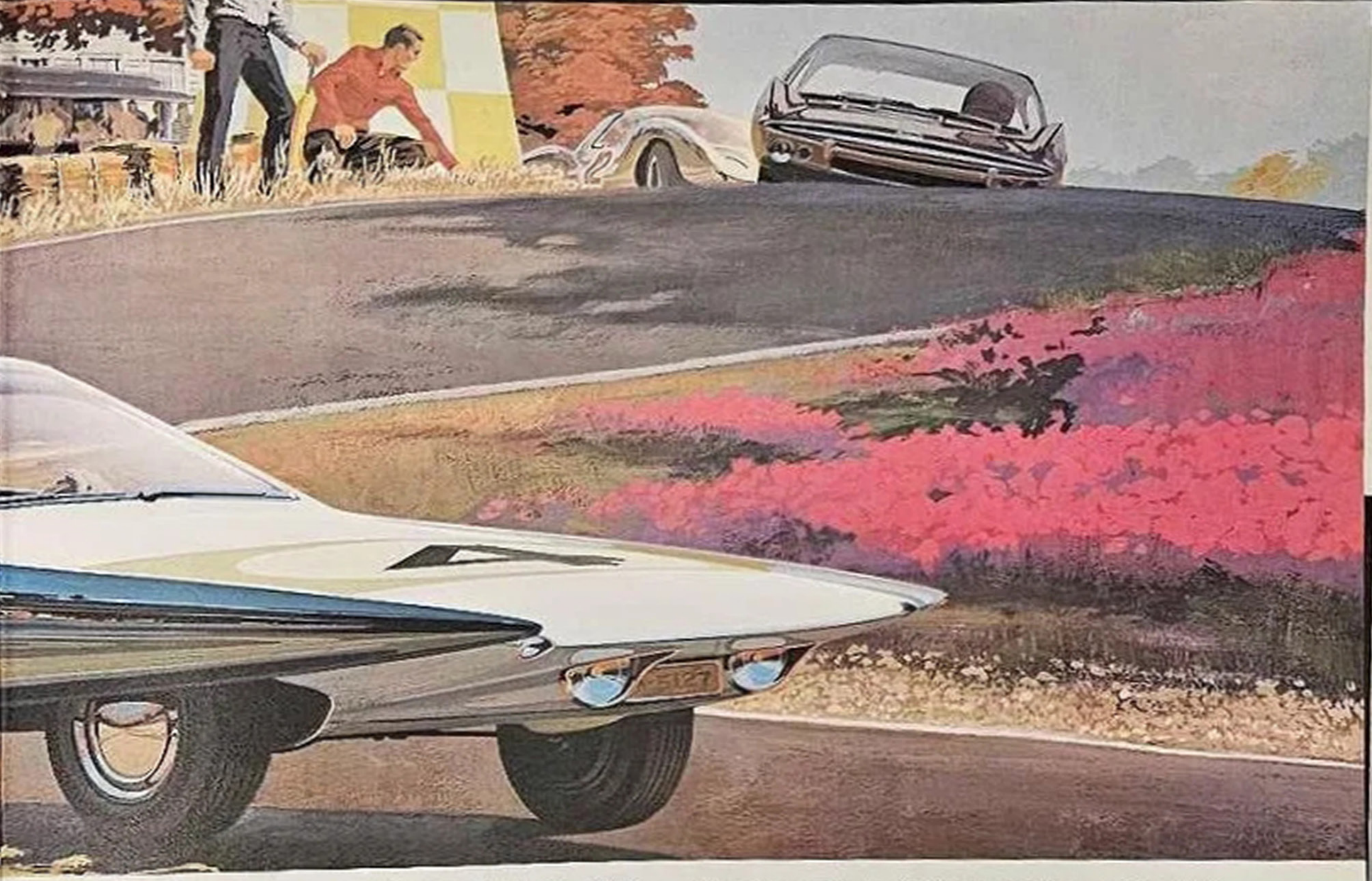
**When shapes or bars are ordered in combination on advantage or when service uses bending is involved, both the tensile and yield strength requirements will be reduced 5,000 psi.

USS "T-1" STEEL

THICKNESS	Thickness Ranges		
	¼" to 2½" incl.	Over 2½" to 4" incl.	Over 4" to 8" incl.
Yield Strength, Ext. under load (min.)	100,000 psi	90,000 psi	90,000 psi
Tensile Strength	115,000/135,000 psi	105,000/135,000 psi	105,000/135,000 psi
Elongation in 2", % (min.)	18	17	16
Reduction of Area, % (min.)	50*	50	45
Longitudinal or Transverse Charpy Keyhole Impact Values (ASTM) Procedure]	15 ft. lbs. at −50°F	—	—
Charpy V-Notch Impact Values			
Longitudinal (ASTM Procedure)	30 ft. lbs. at +10°F	—	—
Transverse (ASTM Procedure)	20 ft. lbs. at +10°F	—	—

THE GAS TURBINE

Whether a high performance vehicle is designed for highway use, test track work or competitive racing, the automotive engineers, designers and stylists profit by the valuable experience which is gained through racing such vehicles. Test results of racing competition augment the test data obtained during private track testing. Two racing objectives are to achieve the lowest fuel consumption and best control at the highest average speed on any kind of road or track. Competitive racing calls for



the lowest weight, the utmost safety through stability and braking ability, the minimum fatigue through the optimum springing and steering control, and the maximum reliability of high performance engines.

Think of a 400 horsepower engine in a dry weight car of 1650 pounds. Such a car equipped with a gas turbine engine could attain 225 mph on a straightaway and accelerate like a rocket. The gas turbine engine's mechanical simplicity, small size in relation to power produced, power-to-weight ratio and stall torque characteristics are intriguing and its latent potentialities are great. The dynamic impact of the surprisingly simple gas turbine engine on the automotive industry continues to be felt. However, packaging for the envelope dimension limitations of race, truck, or passenger cars challenges the designer's ability to arrange turbine components to the utmost compactness if they are to be incorporated into present, confined engine compartments.

EXPERIMENTAL TODAY—
PRACTICAL TOMORROW

The progress made by the automotive engineers with the gas turbine engine in its relatively short development life, plus experience in other fields with these engines, indicates that the gas turbine engine is inherently durable, feasible and reliable, with excellent prospects for eventual use in trucks, buses and passenger cars. Some of the highly desirable characteristics of this engine for such uses are: ability to operate on a wide variety of low-cost fuels; ability to start quickly after extended cold soaking; savings on size and weight; operation for prolonged periods without servicing and smooth operation which gives a steady, vibration-free ride.

The engineers to date have achieved tremendous turbine design simplicity since the gas turbine engine has relatively few parts. The gas turbine engine has about one fifth the parts of a reciprocating engine. It is small and light for the horsepower it develops. Its horsepower delivered at the output shaft about equals that of a reciprocating piston engine. Also, weight savings by design

is clearly demonstrated with the gas turbine engine. Not only is the engine lighter, it saves both the space and the weight required for a radiator and liquid cooling system. And, because of the gas turbine torque characteristics, the gearbox can be made smaller and lighter.

Some of the troublesome operating drawbacks of the gas turbine for automotive use which have received the engineers' closest attention in order to make the gas turbine's competitive power source are: high fuel consumption; slow throttle response and acceleration delay; high exhaust gas temperatures; and excessive power use. All these and factors affecting engine durability and manufacturing costs. These engines require steels having high strength at red heat and depend for their safe and efficient operation on the ability of these steels to maintain their dimensions and adequate strength at these elevated temperatures over long periods of time. By raising the temperature limits of steels used for gas turbine engines, designers increase maximum gas turbine power up to the passenger-race efficiently and economically.

The high temperatures of the gases pose difficult problems in ensuring durability of the turbine blades, since the physical properties of steel are affected by very high temperatures. However, the development of heat-resistant steels and the combination of current new engine designs permit the engineers to exceed such temperatures.

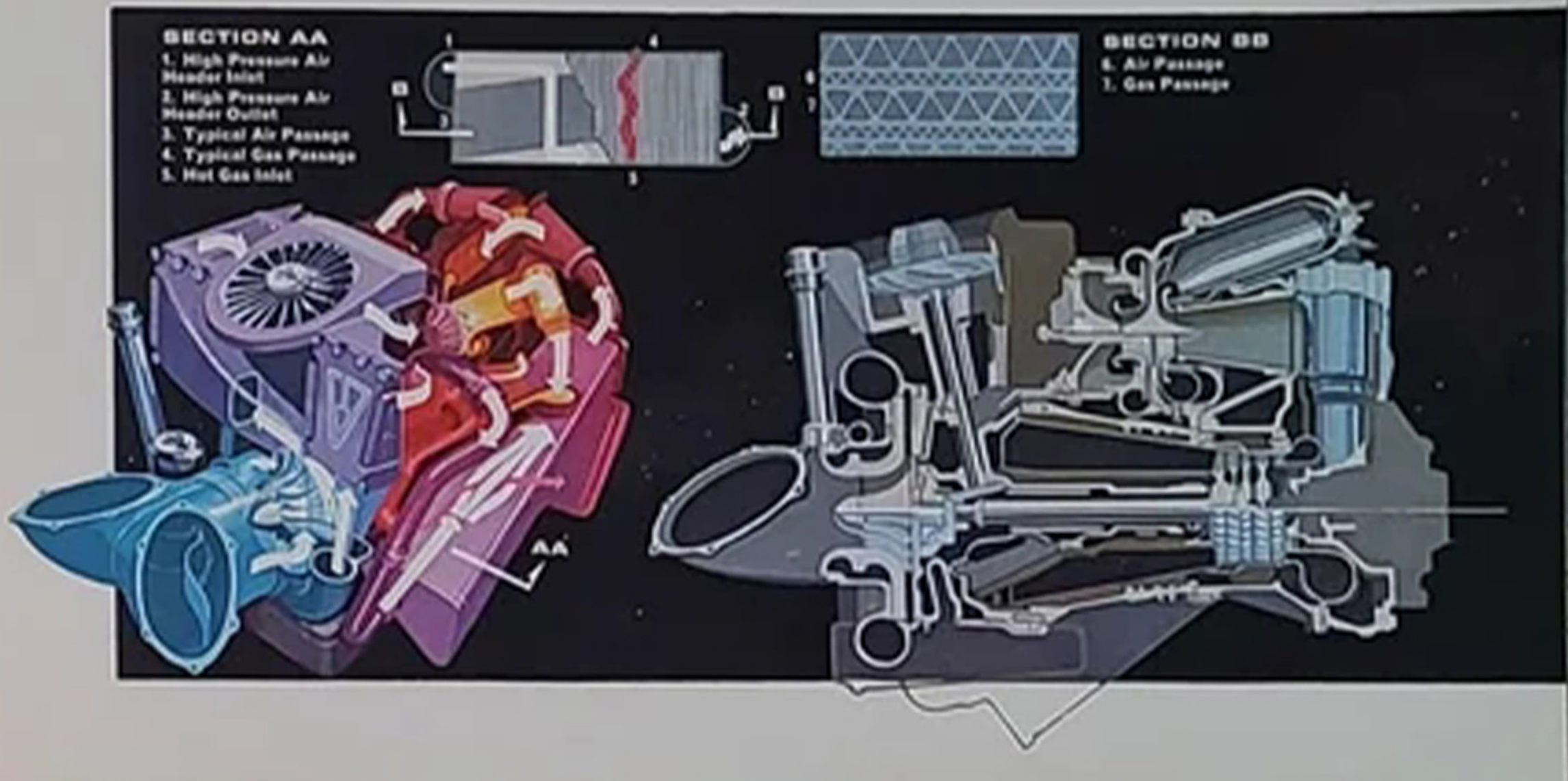
The problems resulting from the excessive efficiency of centrifugal forces are added to the problems of the high temperatures. Blade tip centrifugal forces resulting from extremely high rotational speed, the newest gas turbines up to a hundred times greater than the stresses now encountered by gas pressure on the piston, working down. The tendency for metals to elongate under the effects of centrifugal forces at high temperatures is called growth or creep. Special steels are needed to withstand these temperatures and the creeps of the turbine blade tips since the blade tip wedges are a matter of inches, or about 1/100 the clearance the actual engineers. Resolution of these problems has been vital.

Turbine rotors that perform a double function as absorption elements have reduced the noise level of the motor turbine engine problems. An automobile muffler is little more than a silencer and suppresses the piston engine exhaust noise. Also stationary or drum type regenerators transfer heat from the exhaust gases to the compressed air and reduces most of the exhaust heat formerly wasted. Consequently, fuel economy approaches that of the piston engine. At the same time, the extremely high and constant piston temperatures have not occurred. A gas turbine's rate of acceleration is also substantially up the temperatures its parts can stand. If fuel is added too fast, the engine temperatures may be exceeded. While the gas turbine engine will not accelerate its full speed range as quickly as a piston engine, it will accelerate from near-full speed with road throttle in about three seconds.

The overall efficiency of the gas turbine engine continues to be improved as the maximum allowable temperatures are raised through the use of [illegible] alloy steels. For fifteen years United States steel companies have actively engaged in developing and testing such [illegible] for use in that field. They have developed various steels [illegible] that possess [illegible] and 1350. Several [illegible] and resistance to extreme heat and high [illegible]

TWO-STAGE CENTRIFUGAL COMPRESSOR GAS TURBINE ENGINE CYCLE

In operating principle this turbocharged gas turbine is simple. It receives its incoming air through carbon steel ducts located on either side of the car behind the passenger compartment. This air is then compressed in a first stage, centrifugal compressor. Pressure ratios of 4:1 at this point require compressor speeds of 40,000 to 50,000 rpm. The air is then fed through ducting to the two cross-flow type intercoolers. Here the intercooler fan, turning at 18,200 rpm and discharging into the plenum chamber, cools the air. This reduces the work, size and blade-tip speed otherwise required of the second stage or high-pressure compressor. From the intercoolers the compressed air flows through the high temperature alloy high-pressure compressor which runs at 91,500 rpm and where the air is compressed to an overall pressure ratio of 16:1. The relatively cool air then passes through the compressor scroll to the cool air side of the regenerator. Distribution channeling of this air within the Stainless Steel foil regenerator matrix air cells prevents thermal buckling. And, regenerator channeling of this compressor discharge air provides optimum heat absorption by maximum exposure of the air to the hot turbine exhaust cellular flow passages. As a result, less fuel is burned in bringing the air to its operating temperature. From the regenerator the highly compressed air enters the high temperature alloy can-type primary combustor. Low grade kerosene is sprayed into the combustor where combustion is continuous after a spark from the igniter plug ignites the mixture for starting. The high flow rate of the fuel injection nozzles provides a good spray pattern and efficient combustion. The resulting hot, expanded gases entering the high temperature alloy nozzle are accelerated and directed against the curved blades of the high temperature alloy radial inflow high-pressure turbine. This use of the gases to drive the turbine and high-pressure compressor reduces both temperature and pressure of the gases. So, these gases then pass to the reheat combustor. From there the hot, high pressure gases enter the power turbine nozzles which are fabricated from forged Stainless Steel. These nozzles are actually blades, generally similar in contour to the high temperature alloy steel turbine blades, against which they direct the gases. At the power turbine some of the heat and pressure is converted through an output shaft and planetary reduction gear into torque or rotary motion. More of the heat and pressure is used to drive the low-pressure turbine, which in turn drives the low-pressure compressor through an alloy steel shaft which is welded to the turbine wheel and splined to the compressor wheel. The remaining gases are further cooled by passing through the hot gas cells of the regenerator. In doing so they preheat the incoming relatively cool, high pressure air. Finally, the spent gases are exhausted through twin ports to the atmosphere.

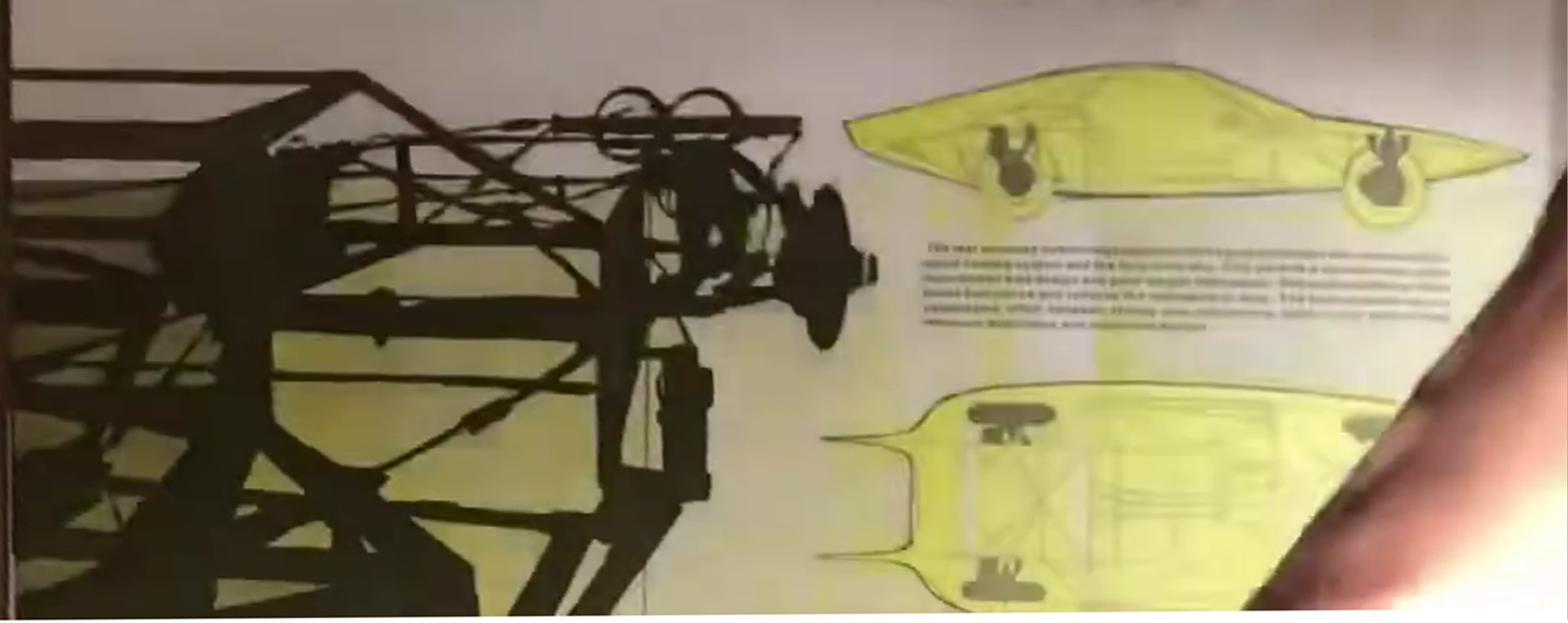


THE PRINCIPLES BEHIND SPACE-FRAME DESIGN

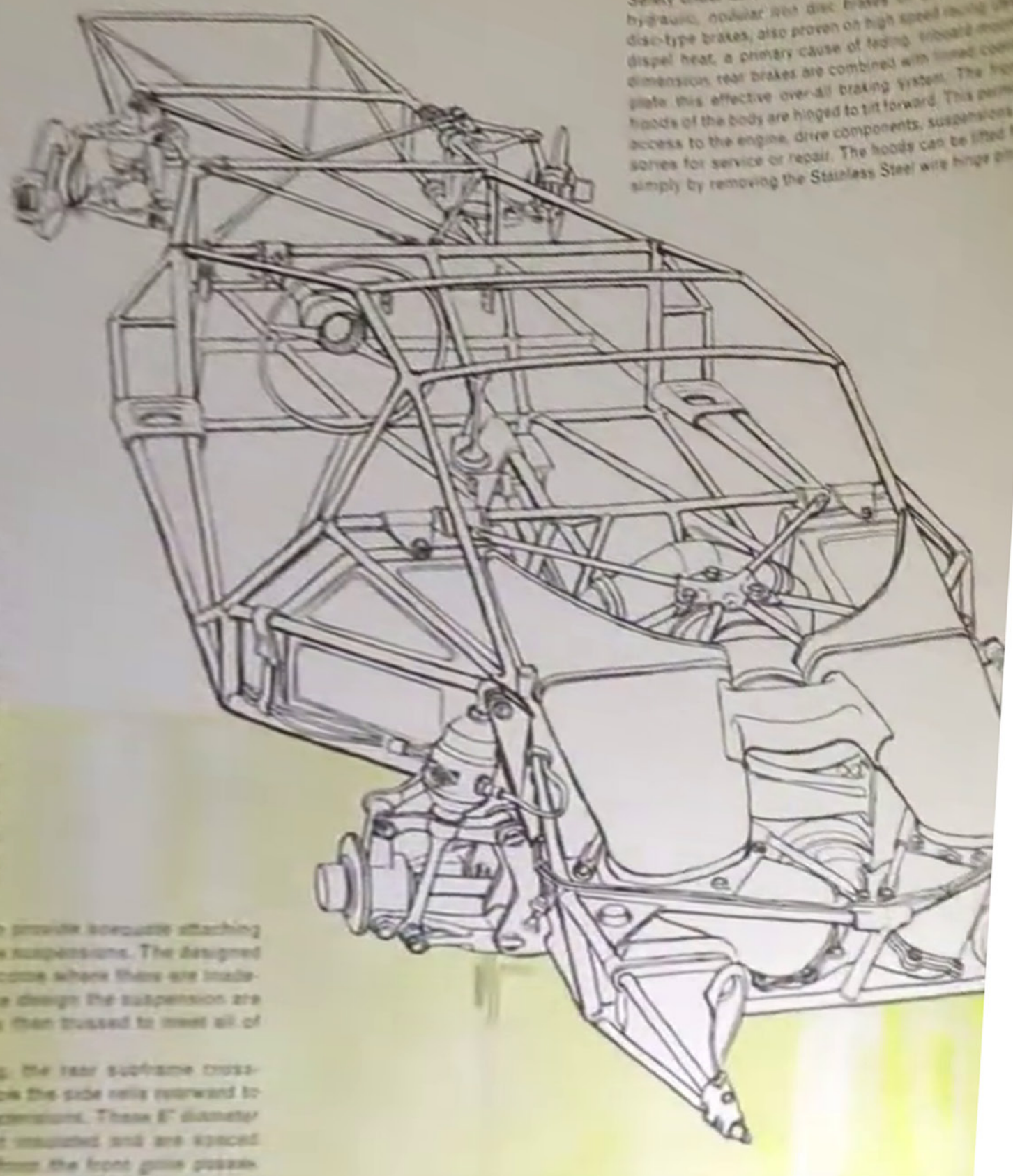
[redacted]

SAFE, LIGHT, RIGID AND STRONG

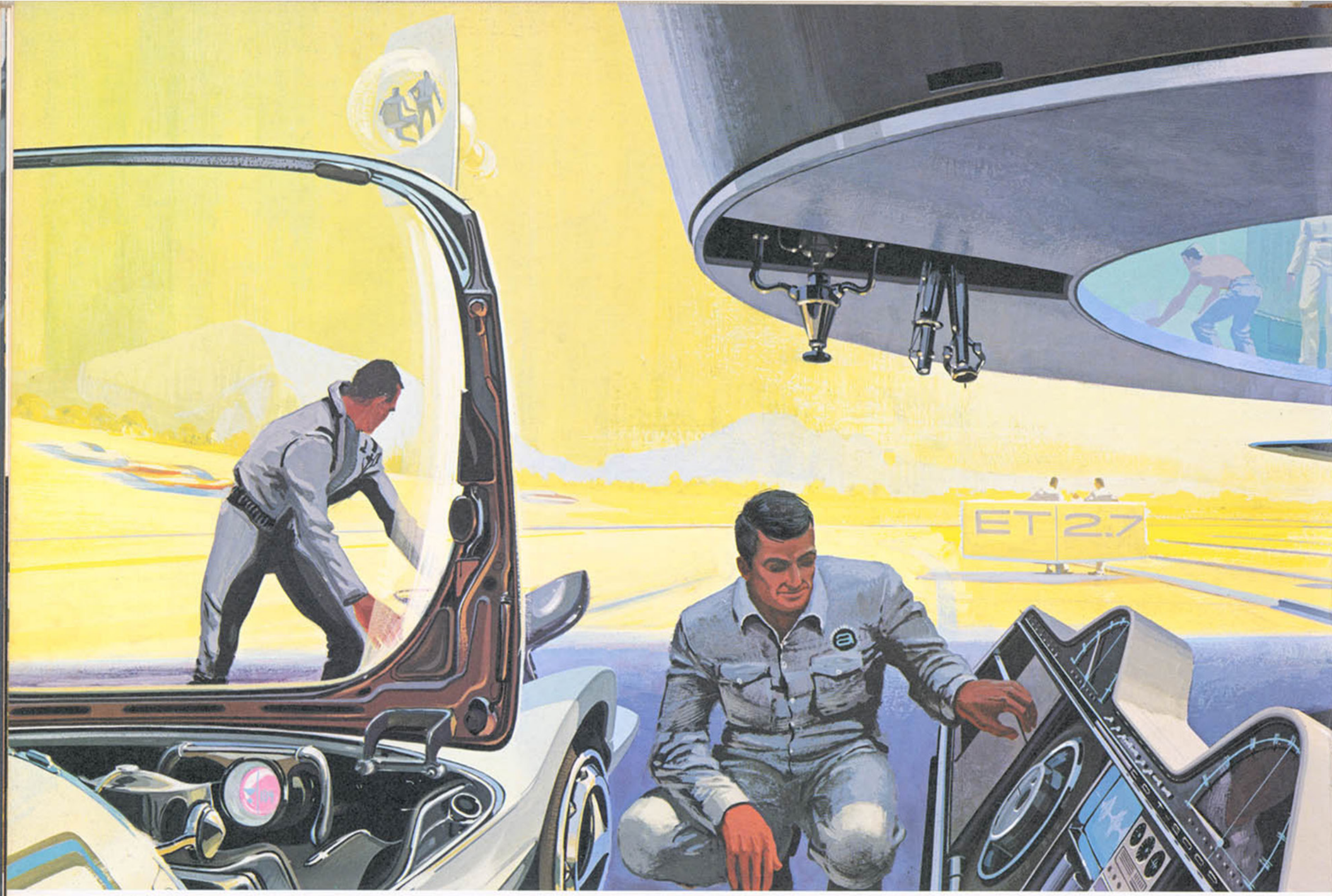
[redacted]



AN IDEA STARTS A DESIGN— RACING PROVES IT

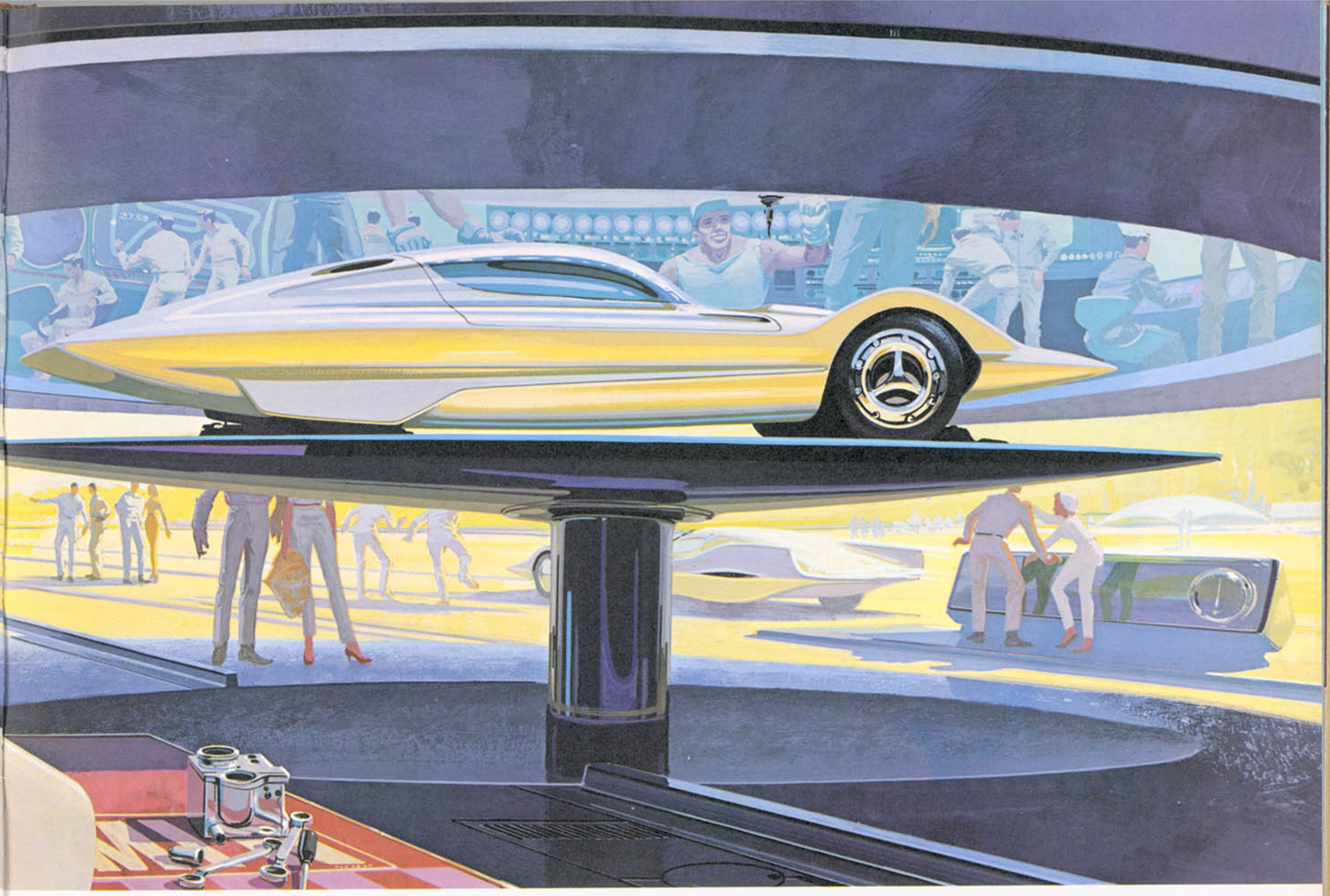


Safety under all driving conditions is provided by this ve
hydraulic, nodular iron disc brakes on the front wheels,
disc-type brakes, also proven on high speed racing cars,
dispel heat, a primary cause of fading. Inboard mounted
dimension, rear brakes are combined with finned cooling
plate; this effective over-all braking system. The front
hoods of the body are hinged to tilt forward. This permits
access to the engine, drive components, suspensions and
panels for service or repair. The hoods can be lifted fro
simply by removing the Stainless Steel wire hinge pins.



STAMPING—AN ANSWER TO LOW VOLUME ENGINES

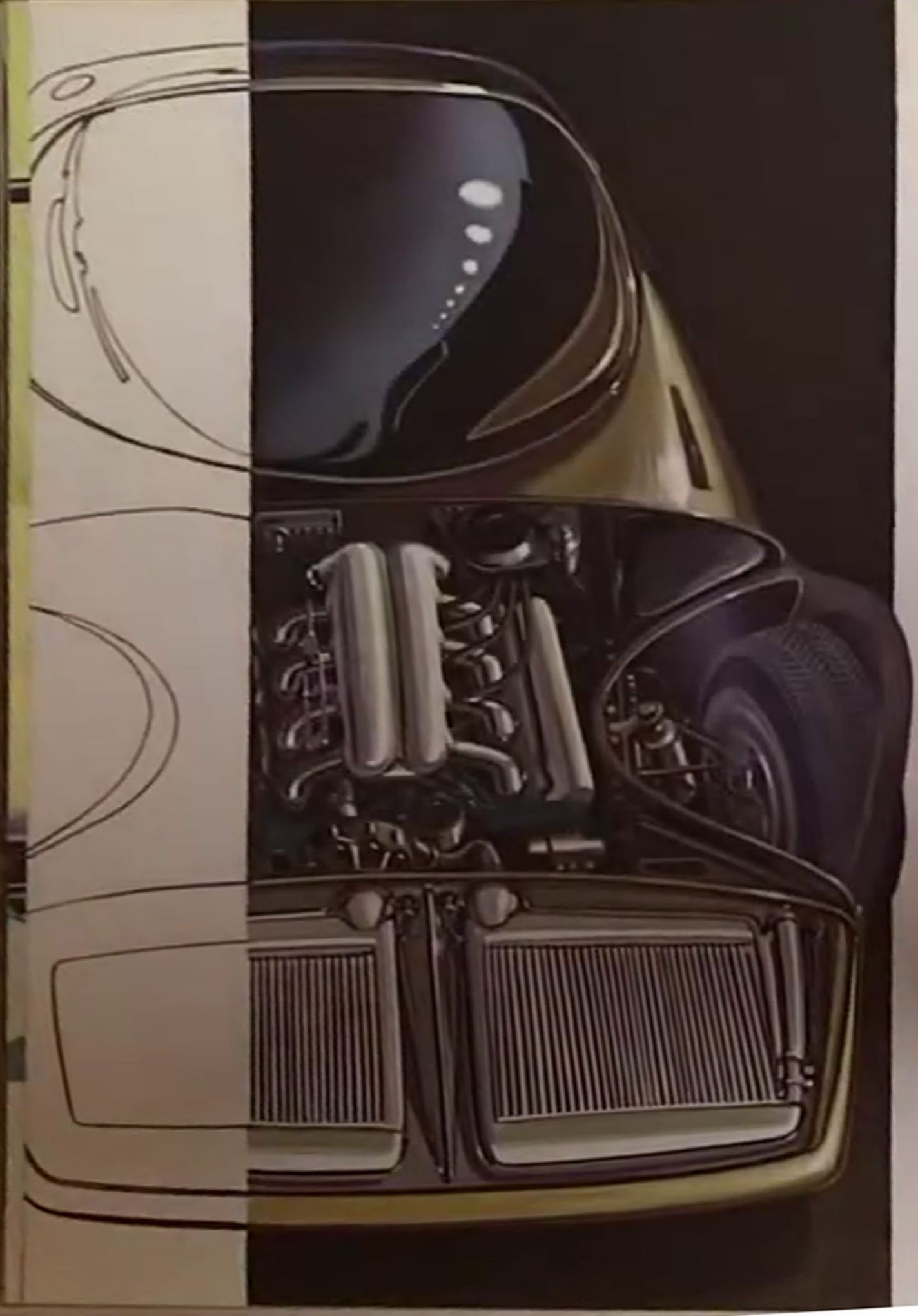
The development and adoption for vehicular use of the sophisticated future engines will still leave a place for the piston engine. For years the piston engine has demonstrated its constantly improving staying powers and impressive qualities of reliability, speed and acceleration. Improved manufacturing techniques, combined with imaginative engineering, often lead to practical design innovations such as this combination stamped Stainless Steel and precision cast, opposed 8-cylinder engine.



MAJOR SPECIFICATIONS:

Type	8-cylinder opposed
Bore	3.00 inches
Stroke	Various, to meet cubic inch displacement desired
Camshafts	Dual, forged alloy steel
Crankshaft	Forged steel, one-piece, circular cheeked
Connecting Rods	Stamped carbon steel
Crankcase	Precision cast, thin-walled nodular or gray iron
Compression Ratio	Up to 14:1
Maximum Power	Develop at 6500 rpm. Red-line at 8000 rpm. Test to 10,000 rpm.

This practical, high-performance engine combines lightness with brute power and is designed to develop a minimum of one horsepower per pound. Its design greatly reduces tooling requirements and simplifies manufacturing techniques to allow efficient, limited production. Displacement is optional with a common bore size through a choice of crankshafts and camshafts.



HIGH HORSEPOWER ON A LOW BUDGET

Unless the production quantity in a given engine size is significant the capital expenditure to tool up is not economically feasible. In limited production of varied horsepower engines the complete group of engines produced should maintain a close design relationship. Controlling engine designs in this manner provides maximum interchangeability of identical parts as well as lowest cost parts. This limited production, stamped Stainless Steel and nodular or gray iron engine is one which would fit into such a controlled design plan. The engine calls for a minimum variety of patterns, equipment and tooling. Its simplicity offers a definite advantage in foundry and machining procedures. The unique construction features of this engine offset the cost of Stainless Steel from which it is fabricated compared to the low cost of cast iron used in conventional engines. It requires about one-third the machining needed on a comparable cast engine. The use of 0.065 inch Stainless Steel compared to a ⅛ inch casting explains the remarkable weight savings. In addition to low weight, Stainless Steel provides superior strength and high corrosion resistance. The use of thin Stainless Steel sections gives a rapid, uniform heat dissipation. The uniformity of its wall thickness minimizes troublesome "hot spots," a common cause of cooling problems.

The prime feature of this lightweight engine is its use of formed Stainless Steel cylinder blocks. These blocks are formed from copper plated Stainless Steel, which is also used for the combustion chambers, cylinders, water jackets, intake and exhaust ports, upper housings and spark plug tubes. Fabrication of this engine begins with flat sheets of Stainless Steel trimmed to size. Intake and exhaust ports are punched and the sheets are then formed into the sides and bottom of the engine blocks. Stamped water galleries are tack-welded to both sides of the blocks. Copper paste, brazing wire and foil are applied to all joints as the components are added.

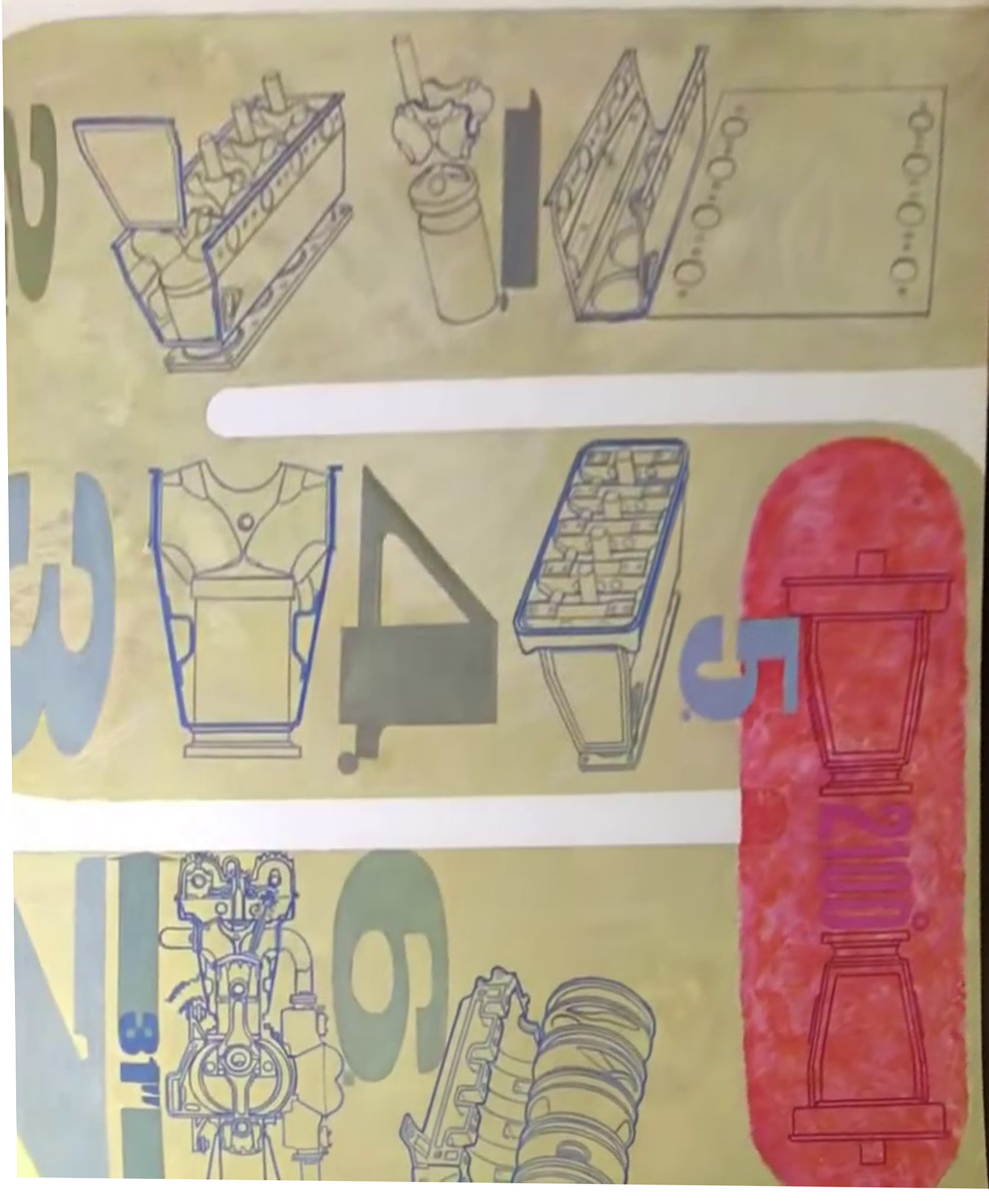
Individual Stainless Steel tubes, with high wear-resistant chrome molybdenum steel liners, form the cylinders. Combustion chambers and ports are formed of Stainless Steel. These and the spark plug tubes are inserted in the blocks.

End sections of the blocks are placed in position and the tops of the blocks are fitted. When all components are in position they are tack-welded at several points to maintain accurate alignment. Then all parts of the entire blocks are joined by brazing in a hydrogen-filled oven at 2100°F. At such temperatures the copper flows into every crevice so a metallurgical and mechanical bond is obtained. These brazed engine assemblies are then fully annealed. Distortion in this engine is held within 0.002-inch. No cleanup and little finish machining is required. This unitized block design, plus Stainless Steel's high strength, permits exceptionally high compression ratios.

Variable displacement is readily possible by changing the crankshaft to change the stroke. Timing is modified by changing the forged alloy steel cams which ride in five plain bearings. The cams are driven by a combination alloy steel gears and carbon steel roller chains. The cam drive cover cases which are made of nodular or thin-walled gray iron provide extra stiffness to the assembled engine. All of the different displacement engines weigh approximately the same.

The forged steel, circular-cheek-design crankshaft with its rugged construction and shorter length has greater stiffness than a conventional crankshaft. In this design the cheeks form the main journals and are encircled by main roller bearings. Such a design permits an extremely short engine length and a minimum distance between the cylinders. The use of forged steel, the short crankshaft length and the exceptional bearing support area all reduce deformation, vibration and torsional stresses of the crankshaft.

New production techniques now permit precision casting and weight reduction of such gray iron or nodular iron parts as the crankcase and cam drive cover. The secret is the thinner walls of these new castings. They have a wall thickness of approximately 0.10 inch compared to 0.14 to 0.15 inch in ordinary cast iron castings. Such thinner castings weigh less for a given size.

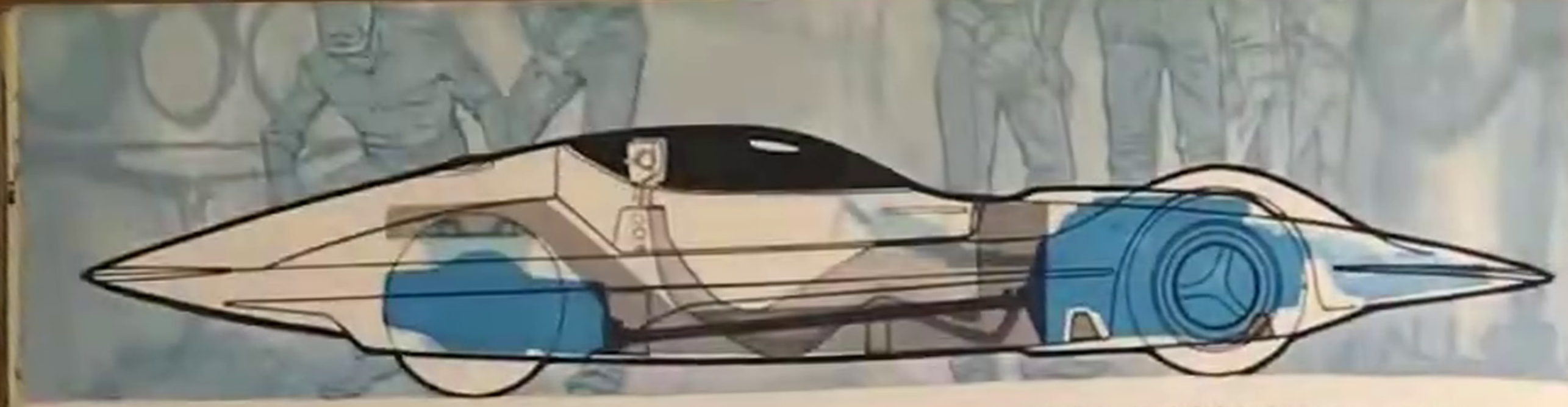


Beauty and Durability Etched in Steel

Advances in education and civilization bring greater increase in aesthetic appreciation. Tomorrow's family car will meet new demands for beauty and still fulfill the increased demands which advanced technology and faster travel will make upon its engineering and its design.

Rocker panels, door sills and door skirts of this future car pose no problems of corrosion. Made of galvanized steel, they meet exacting standards for corrosion resistance and attractive appearance.

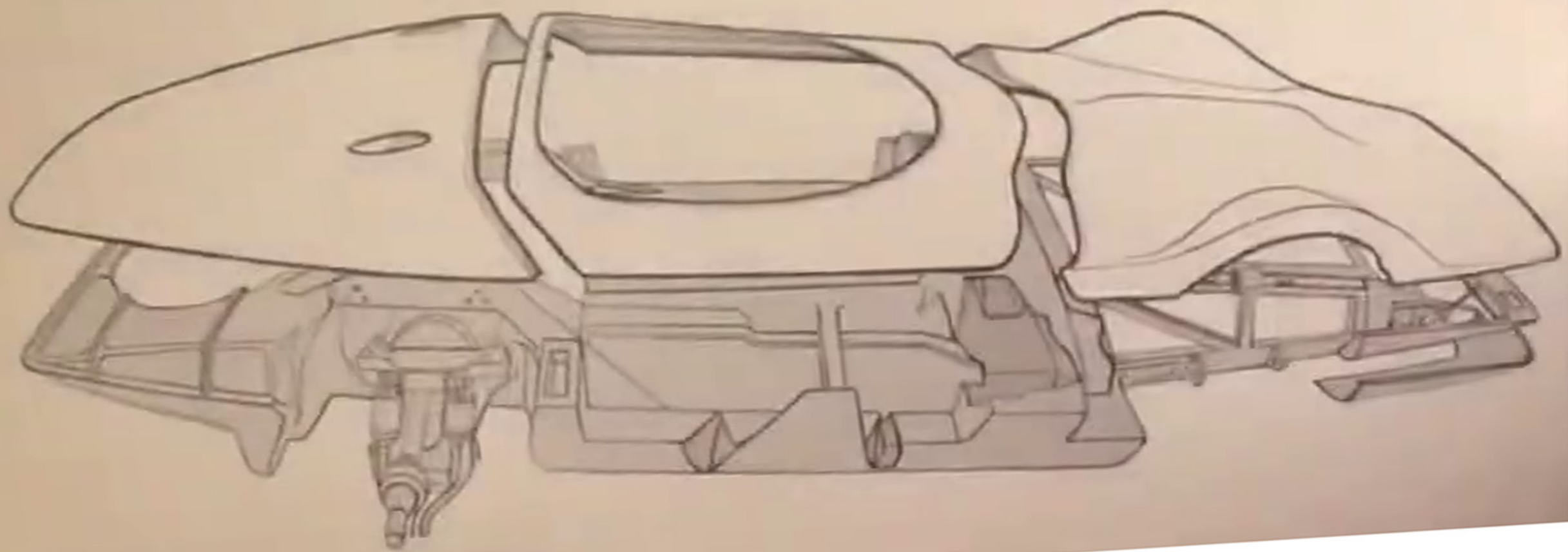
Of interest in this little car is the woven steel wire door panel which conceals the car's radio and heater. Further, the use of soft, supple, woven steel fabric for the cushion facing solves another major problem—upholstery wear. A perforated stainless steel grille, matching the body molding, conceals the brake cooling air intake. A large, pad-type combination brake and accelerator pedal of fluted stainless steel gives instant, effortless control.

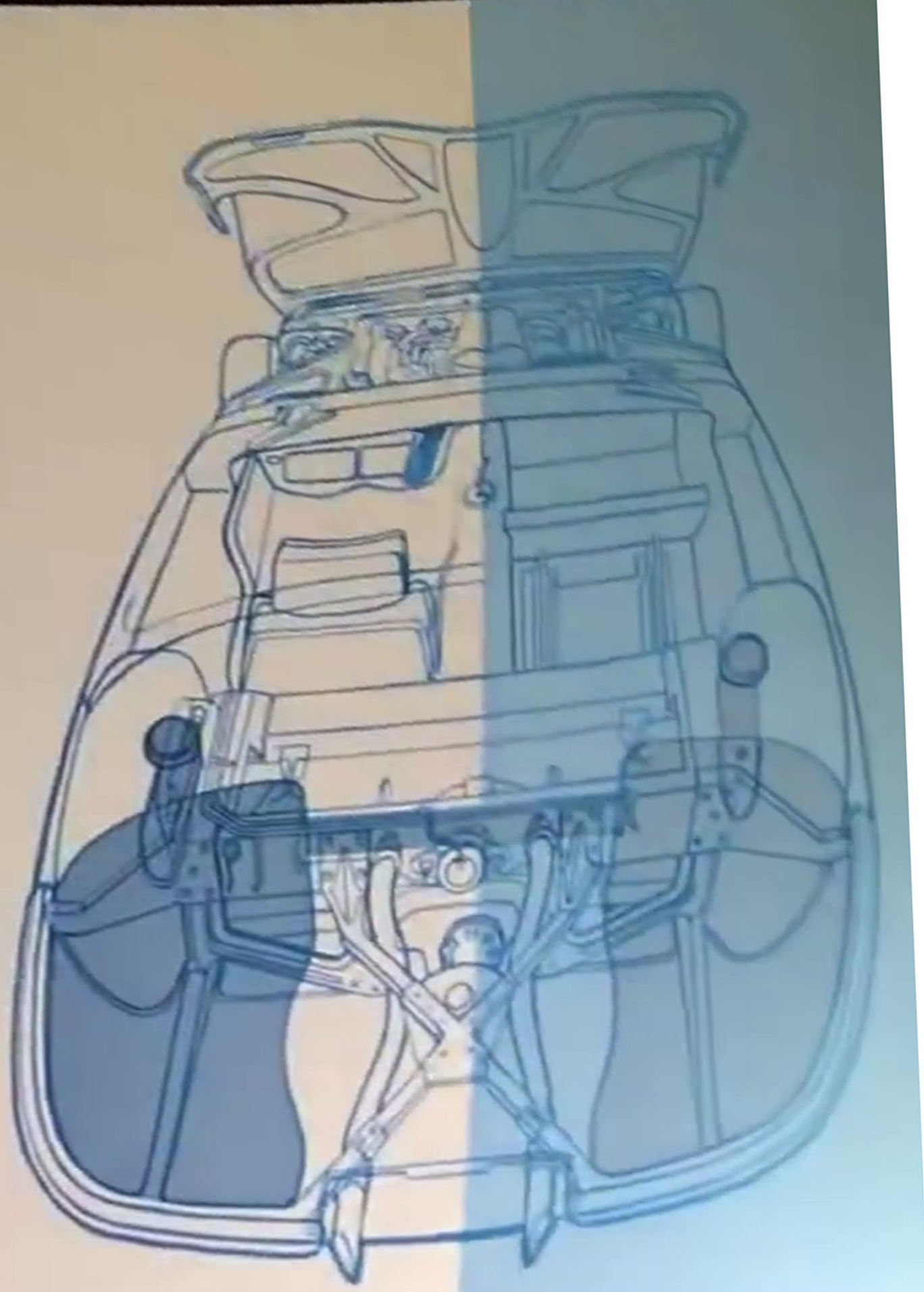


THE PLAN – TO PROVE AND IMPROVE

This straight, carbon steel, stressed-skin body design has been proven in searching tests under the severe conditions of the race course. Based on a combination of space configuration, monocoque principles and carbon steel tube front and rear stub-frames, it is a remarkably rigid structure with a worthwhile savings in weight. The fan-mounted, thin radiators, with their integral Stainless Steel expansion tanks and the 180° engine, permit a low frontal area design. Bulkheading between the engine and radiator compartments provides unrestricted ram air flow through the thinner fans radiators.

For ease and economical servicing, the forward and rear stub-frame assemblies permit quick removal of the complete front or rear axle mechanical components which include the engine, transaxle, suspensions and wheels. Rubber insulating the stub-frames at their mounting points on the main frames isolates road noise and harshness from the passenger compartment.





II Temperature (F) at which oxidation (scaling) becomes appreciable

III Temperature (F) at which the 0.2% offset yield strength is 17,500 psi

IV Temperature (F) at which

2000F
1900F
1800F
1700F
1600F
1500F
1400F
1300F
1200F
1100F
1000F
900F
800F
700F

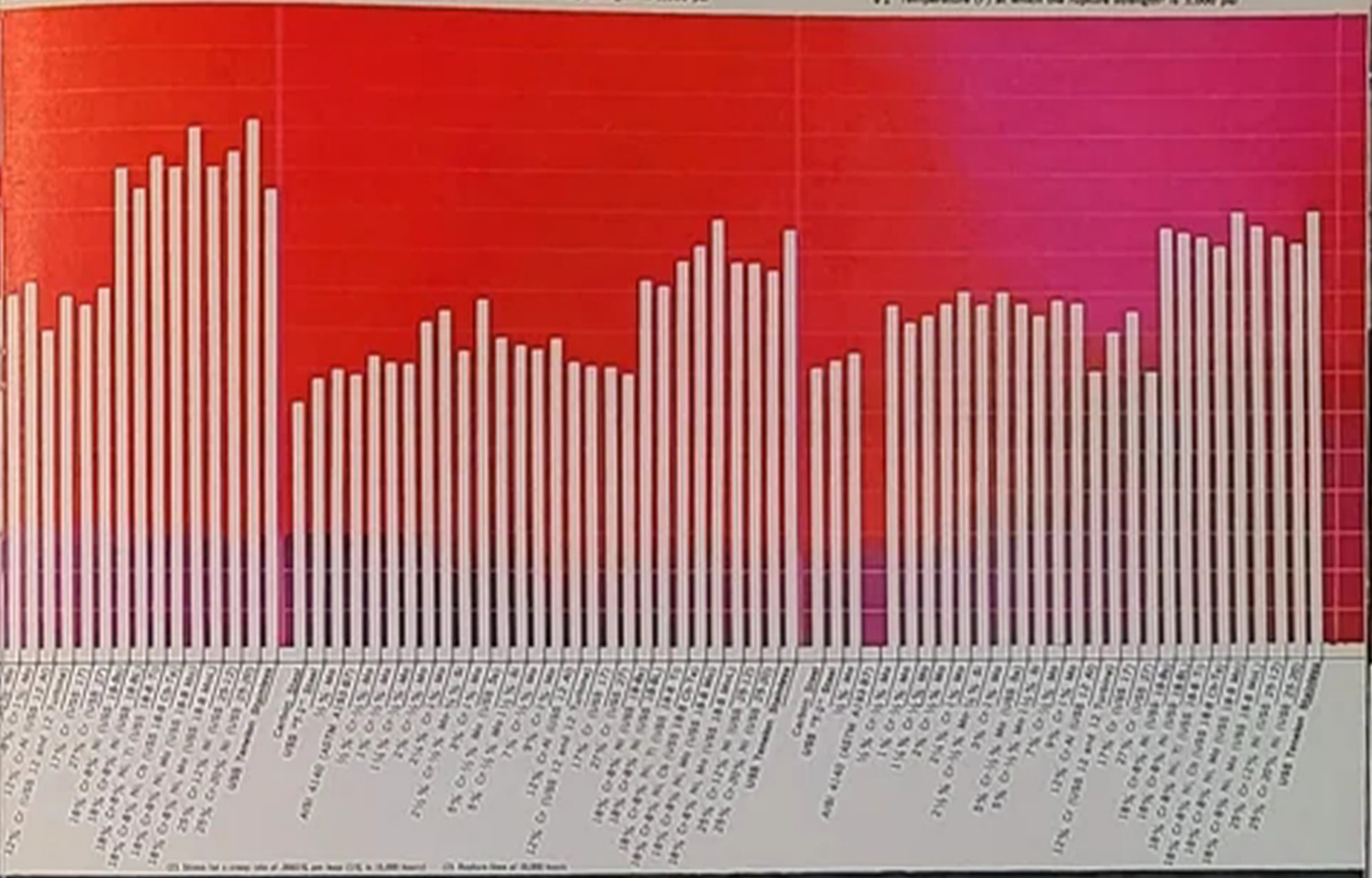
I Chromium content (per cent)

(1) Weight gain of 10 mg per sq. cm. in 1,000 hours

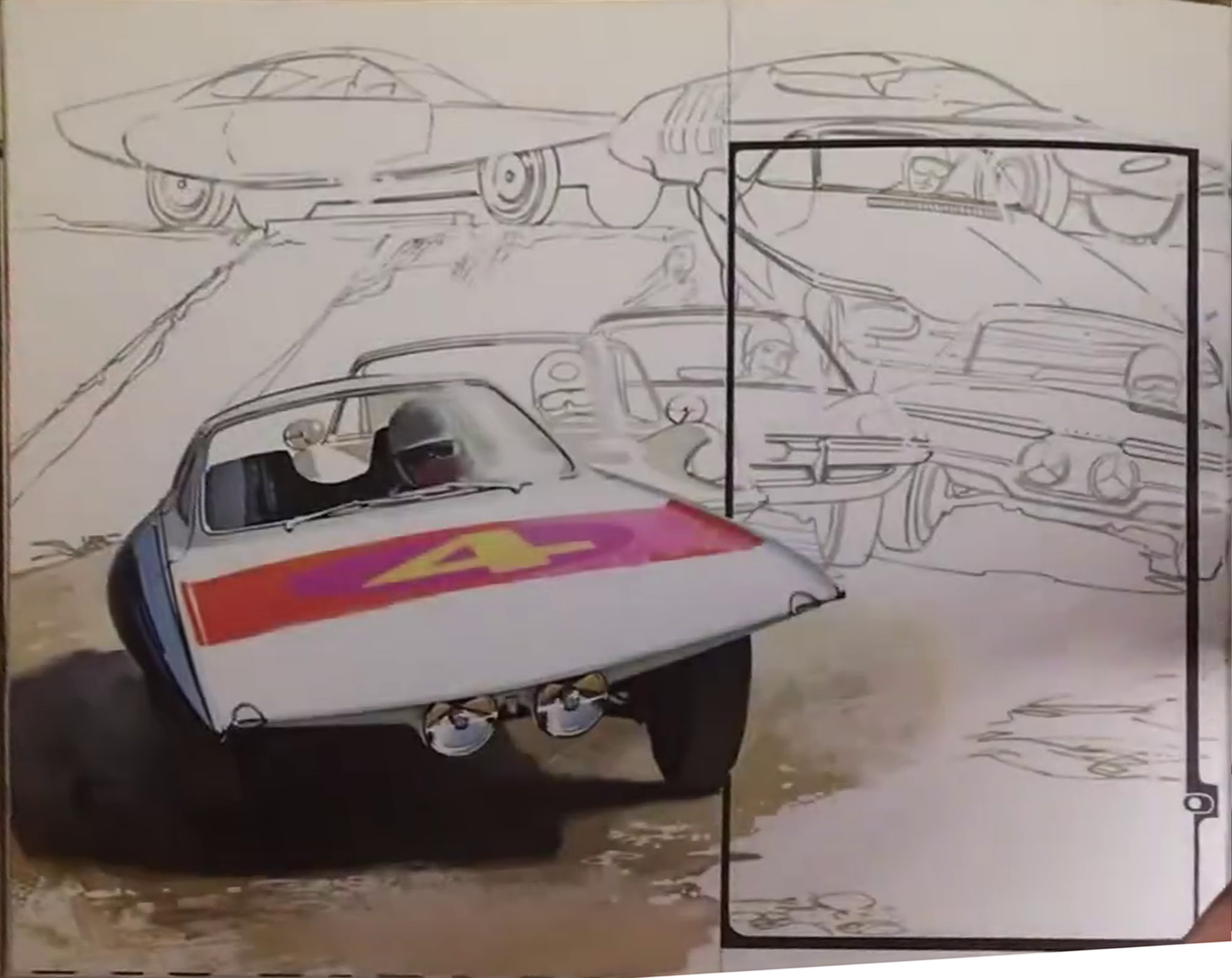
e tensile strength is 17,500 psi

V Temperature (F) at which the creep strength[1] is 3,000 psi

VI Temperature (F) at which the rupture strength[1] is 3,000 psi



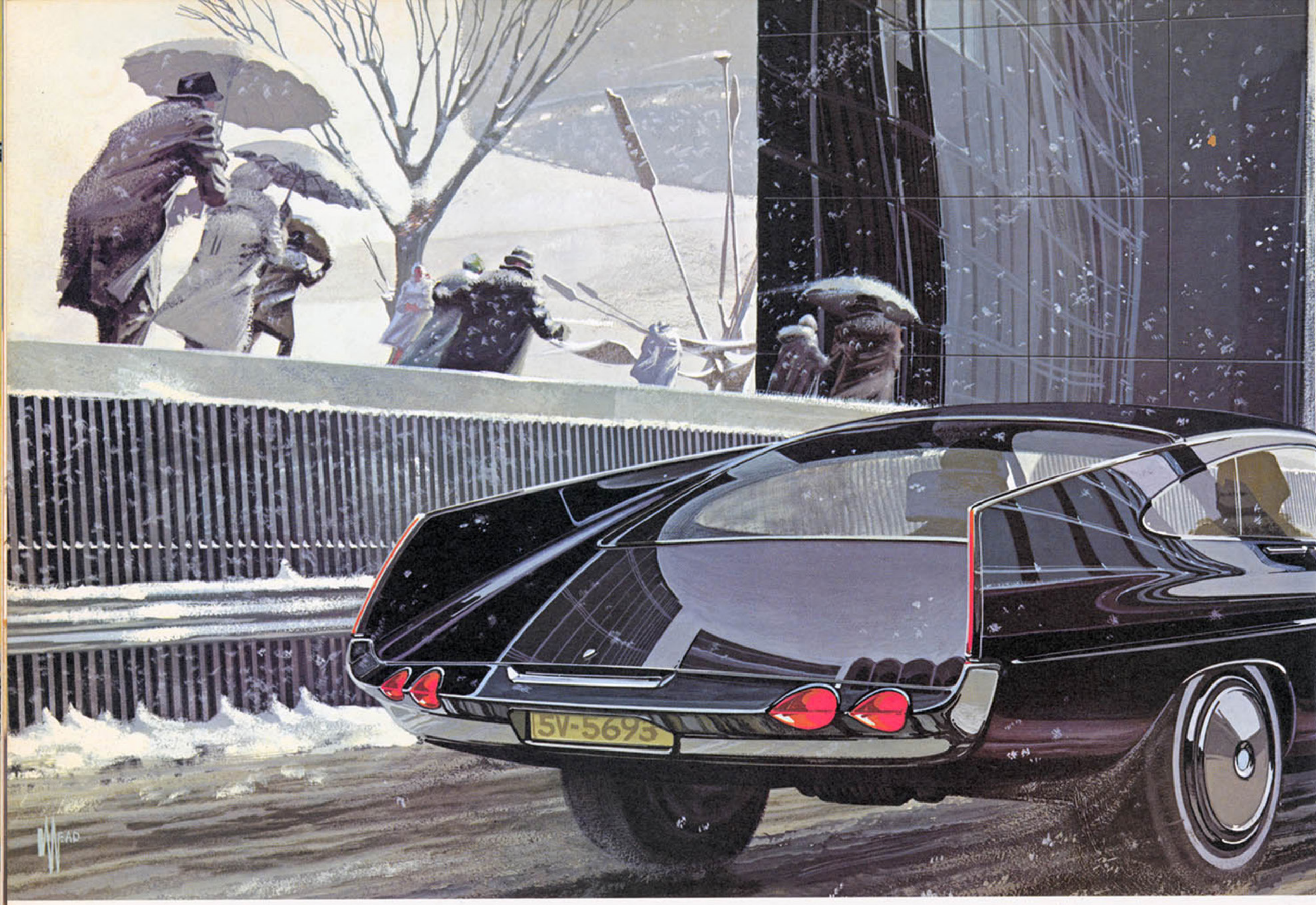
temperatures



TYPICAL MECHANICAL PROPERTIES

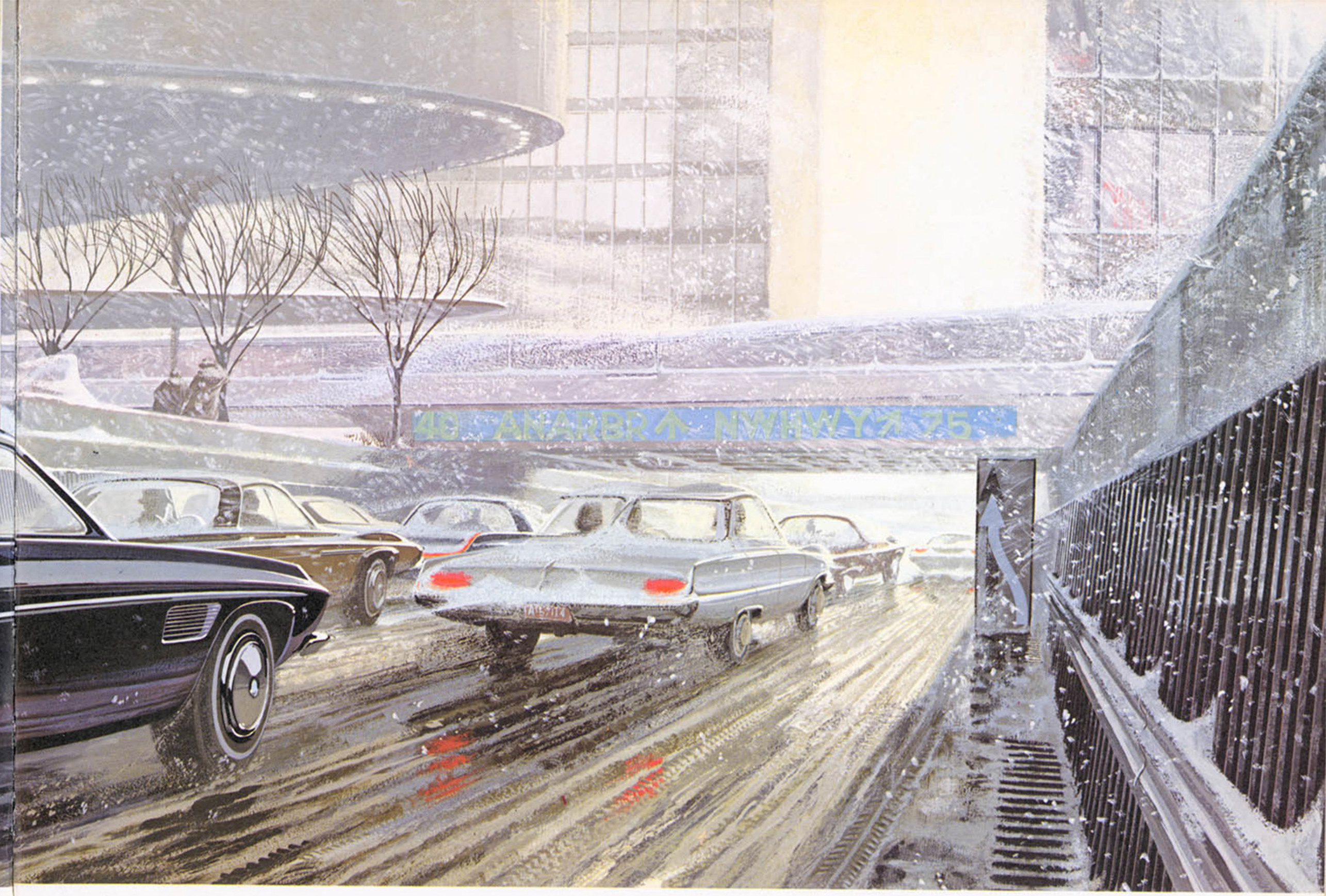
STAINLESS STEELS

	Type 301		Types 302, 303 and 304	
	½-Hard	Full Hard	An-nealed	Cold Worked
	—			
	Type			



INCREASING STEEL'S LIFE SPAN

Weather will always be with us, and too often it is "dirty weather." Dirty weather to a motorist quite often means worry over corrosion from sodium and calcium chloride salts and cinders used on northern roads and thoroughfares for deicing. These corrosive conditions, plus corrosion problems resulting from the box-type construc-



tion of unitized bodies, have resulted in an increased emphasis on precoated metals. Such metals as aluminum-coated steel, galvanized steel, chrome plated USS PAR-TEN steel and USS Stainless Steels have become the work-horses for effective corrosion resistance and control. There are many advantages in using these steels. They provide uniformity of appearance; they have a low product cost, especially for mass produced parts; they furnish a good paint base when the surface is given proper preparatory treatment; they improve the product durability through their good corrosion resistance; and they withstand severe forming.

TYPICAL FORMING PROPERTIES OF CARBON STEEL COMPARED TO MORE CORROSION RESISTANT STEELS

Mechanical Properties	C 1010 Carbon Steel as a Standard	Pre-Coated Steels		Stainless Steels		
		Galvanized	Aluminum Coated	Series 300	Series 400	Series 400
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	105	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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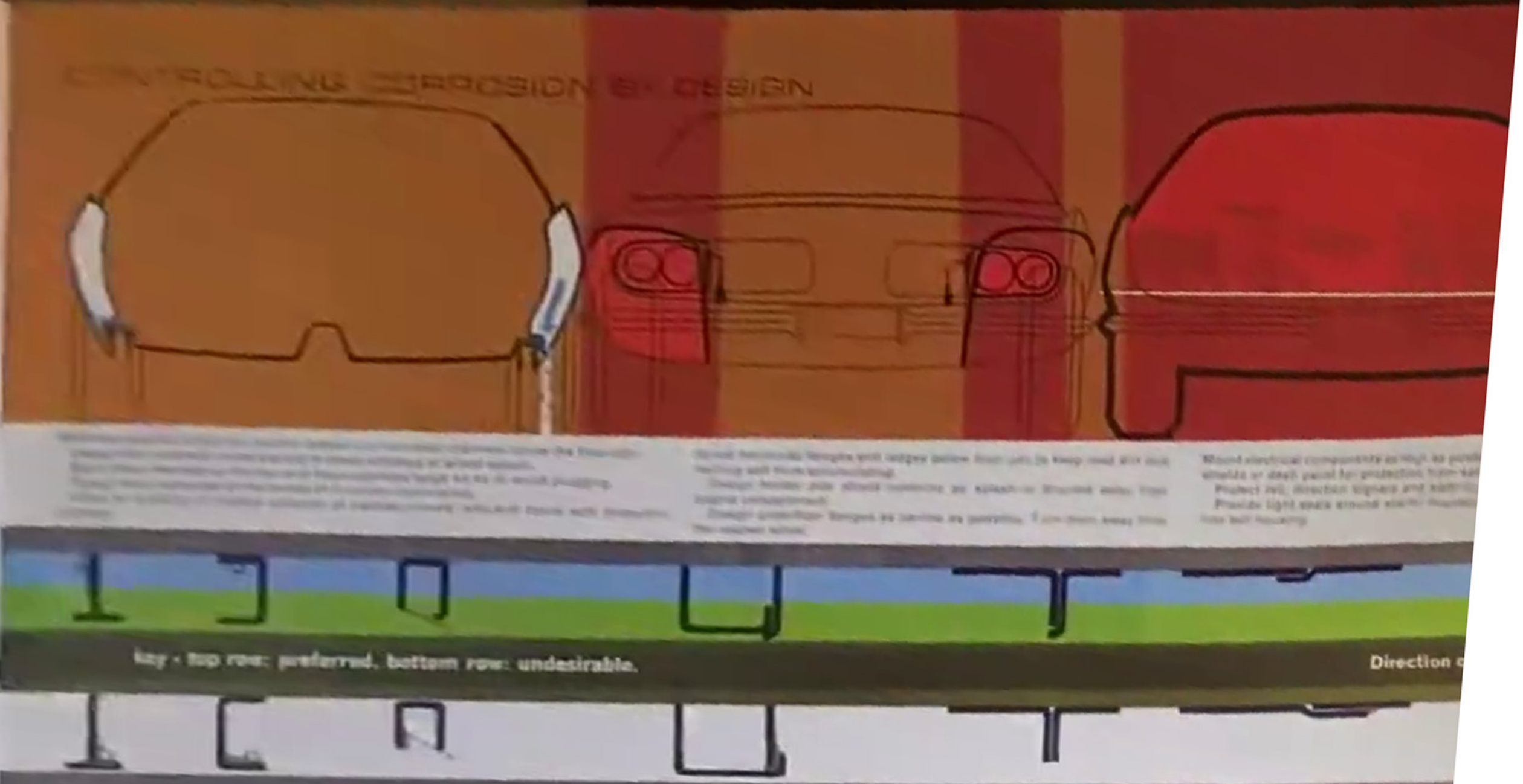


key - top row: preferred, bottom row: undesirable.

Direction o

EXTRA CORROSION PREVENTION MEASURES

TYPICAL MECHANICAL PROPERTIES

USS PAR-TEN STEEL

Strength With Surface And Ductility

USS PAR-TEN steel is a high-strength low-alloy steel intended primarily for use in highly finished end uses, such as automotive bumpers, bumper guards and similar applications after removal of a substantial amount of the surface by grinding.

SUMMARY OF ENGINEERING DATA

TYPICAL MECHANICAL PROPERTIES .239" and under in thickness	
Yield Point, psi	45,000
Tensile Strength, psi	62,000
Elongation in 2", per cent	29
Cold Bend—180°	Flat

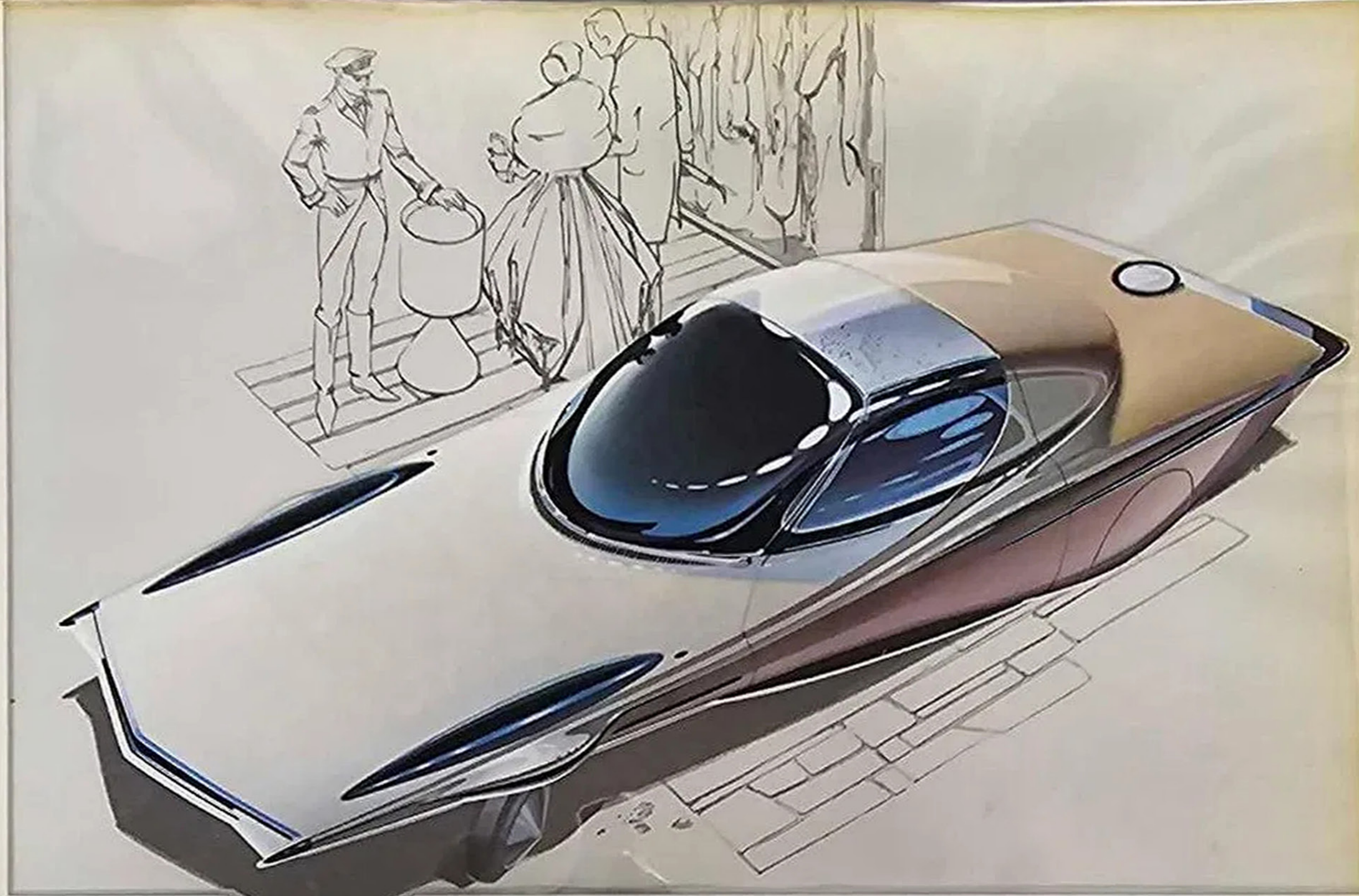
ASTM Standard specimens, minimum number of tests and ductility modifications apply.

PRE-COATED CARBON STEEL

Regular and Differential Coated Galvanized Carbon Steel Sheet and Strip

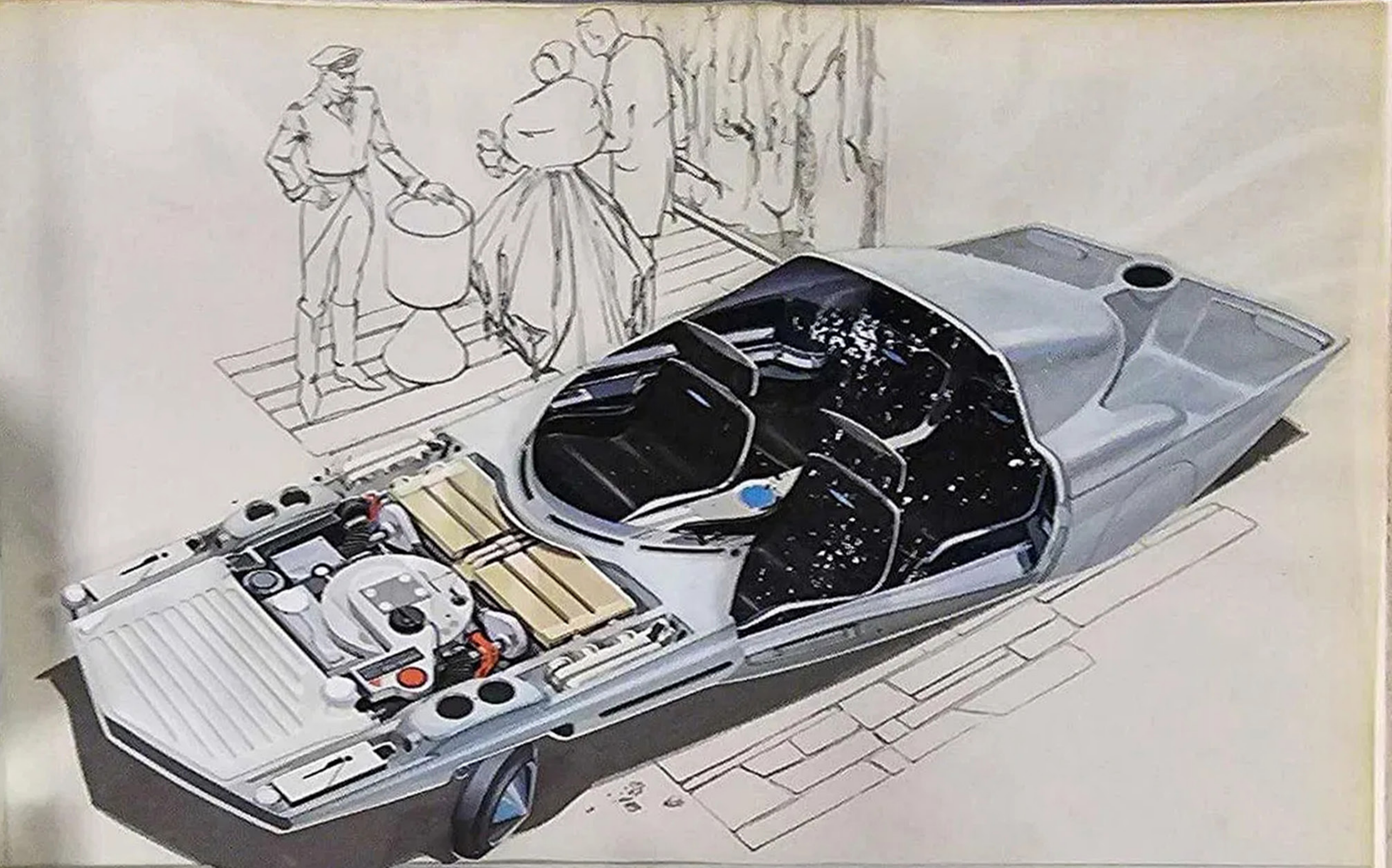
	CQ	DQ	DQ -SK
Yield Point, psi	30-40,000	28-38,000	25-35,000
Tensile Strength, psi	45-55,000	43-53,000	40-50,000
Elongation, % in 2"	29-35	30-40	34-44
Rockwell "B"	50-65	47-57	45-55

Aluminum Coated Carbon Steel Sheet and Strip			SK
Yield Point, psi	35-45,000	–	35-45,000
Tensile Strength, psi	45-55,000	–	45-55,000
Elongation, % in 2"	23-33	–	28-38
Rockwell "B"	55-70	–	50-65



A car is more than a shape in motion—it is the solution to hundreds of design and materials problems faced by the engineer and the stylist. The materials they select must perform dual functions of skin and structure. Drawing qualities must conform to design-change variations. These materials must be inexpensive commensurate with their performance requirements. Fastenability and ease of fabrication are essential. High impact properties are important. Paintability with minimum preparation is a requisite. Corrosion and abrasion resistance is vital.

There are USS steels to answer the most difficult exterior design problems.

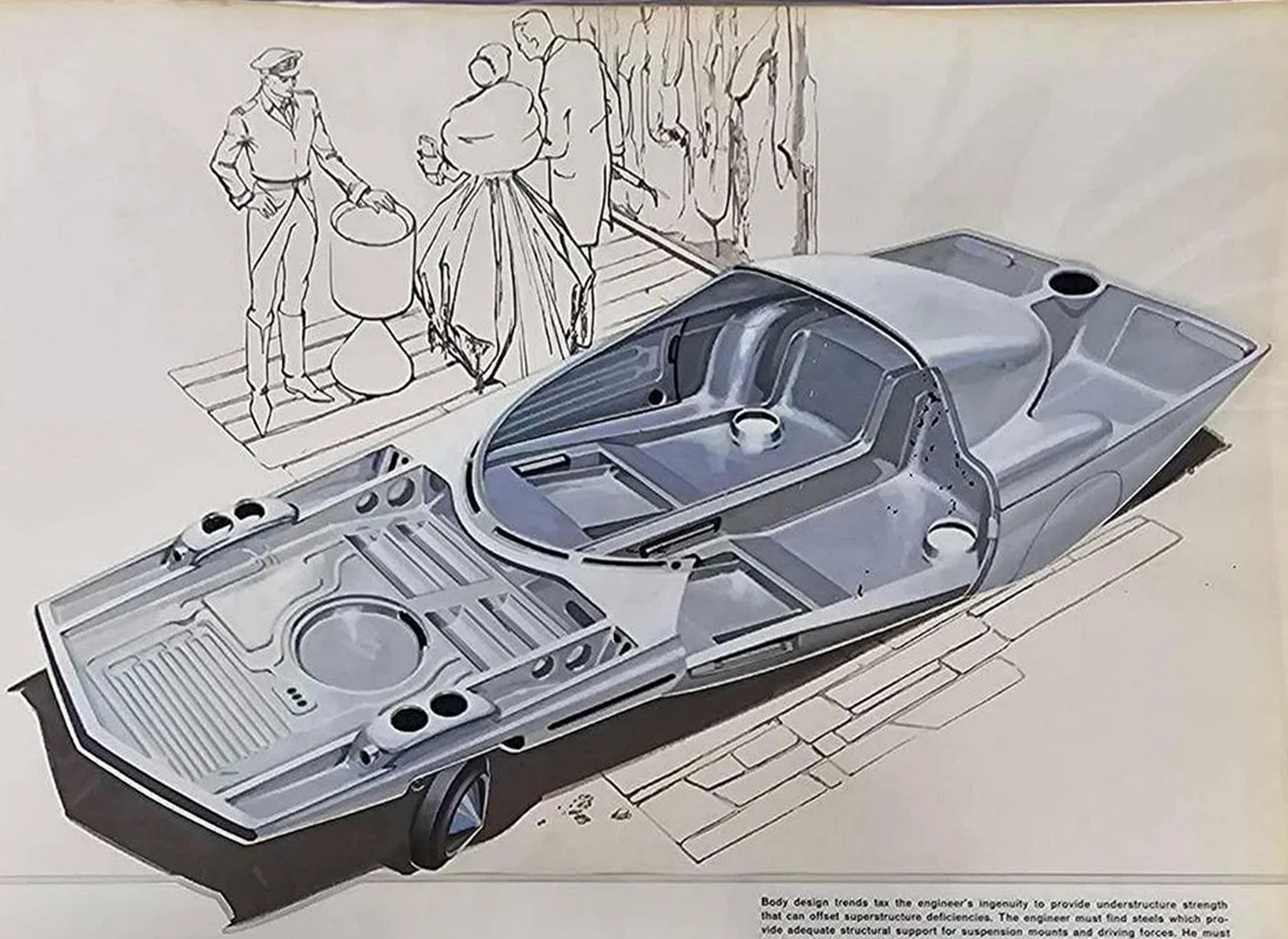


The many, diverse engine steels must meet the engineer's challenges in a manner consistent with performance, manufacturing techniques and cost limitations. They must have dimensional stability at high rpm through the full temperature range. They should permit a high horsepower to weight ratio, withstand endless torsional, compressive and bending stresses and be resistant to fatigue from constant load reversals. They should be able to accept high shaft loadings and high rpm under red heat conditions. They should lend themselves to cold or hot forging to close tolerances and thin dimensions.

There are USS steels to meet the demanding requirements of efficient engine design.

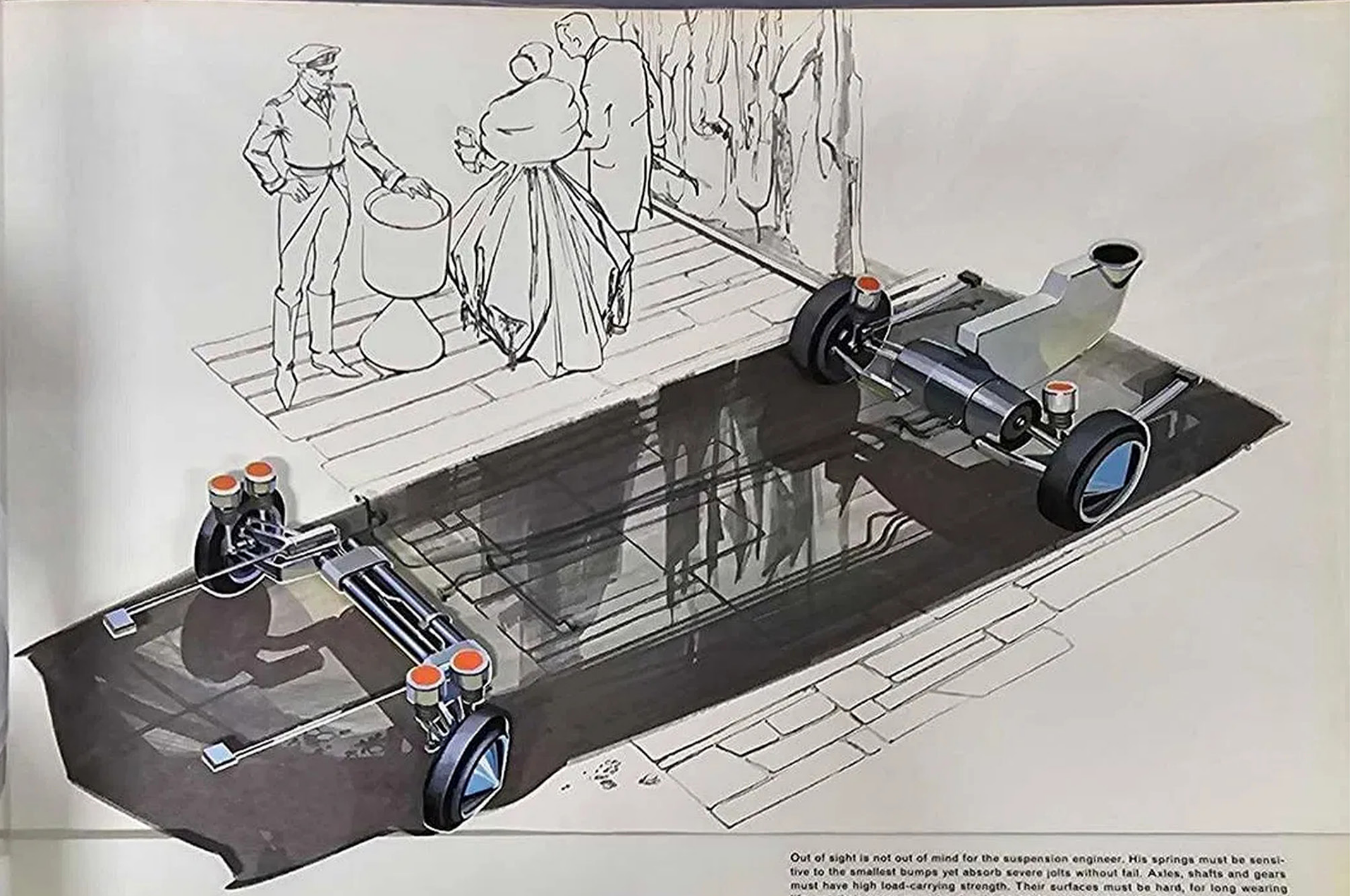
The engineer and stylist have a choice of interior steels which combine structural functions with excellent noise damping capacity. They combine structure and trim finish in one stamping. They provide highlight brilliance and points of contrast so attention is retained. They furnish resilient comfort. These steels also have aesthetic qualities in their patterns and give a feeling of dignity, stability and security. They require only a minimum of maintenance. They can be thin skinned and yet be rugged, rigid and strong.

There are USS steels to fulfill the most rigid interior design requirements.



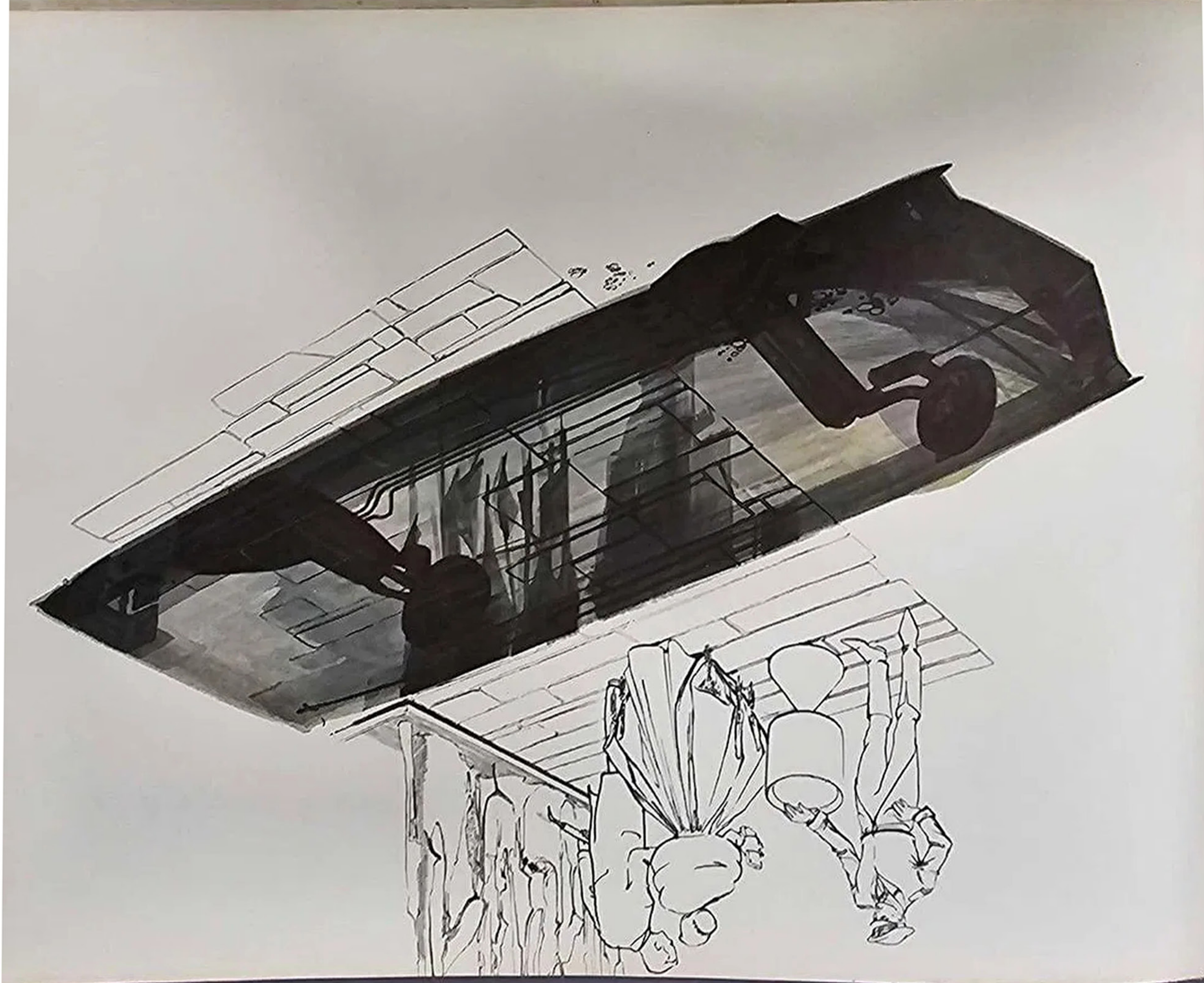
Body design trends tax the engineer's ingenuity to provide understructure strength that can offset superstructure deficiencies. The engineer must find steels which provide adequate structural support for suspension mounts and driving forces. He must find ways to reduce weight without loss of structural strength. Framing members must give high strength and reduced weight. He must design for built-in safety for crash conditions and he must consider functional components as integral parts of the load-carrying structure. His choice of precoated steels must be compatible with current corrosion proofing practices and his designs should improve performance by providing a lower weight to power ratio.

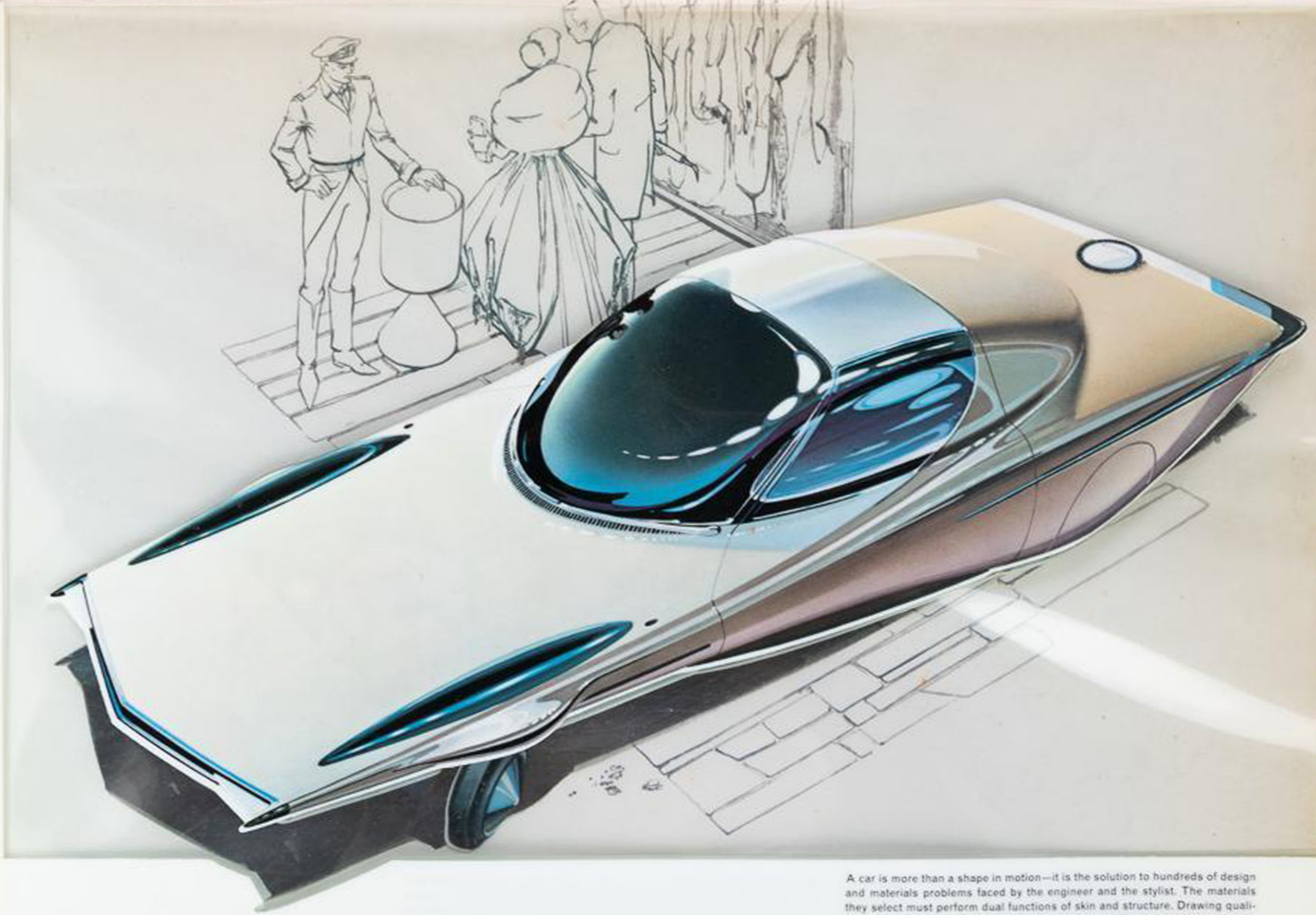
Most body design and materials problems facing the engineer can be answered by USS steels.



Out of sight is not out of mind for the suspension engineer. His springs must be sensitive to the smallest bumps yet absorb severe jolts without fail. Axles, shafts and gears must have high load-carrying strength. Their surfaces must be hard, for long wearing life, yet their cores must be ductile so as to withstand tooth-clashing, impact, quick shifts and sudden power surges. Suspension arms must be rigid to prevent deflection and misalignment. Power steering components must withstand flying rocks without denting. Wheels must run true without hop or run-out, and wheel covers must remain sparkling bright even under the worst corrosive and abrasive conditions.

There are USS steels to help the engineer solve the most difficult chassis problems.





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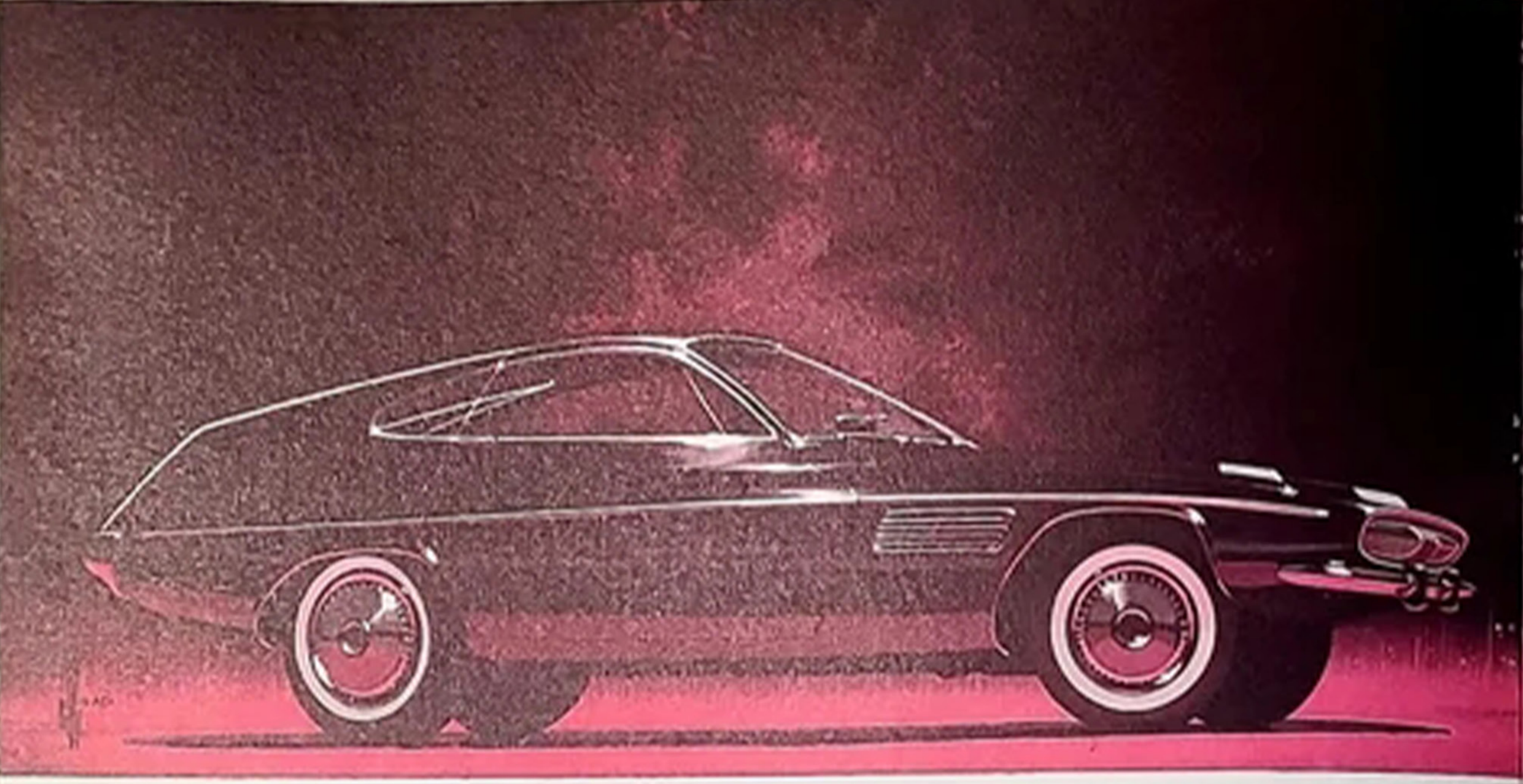
There are USS steels to answer the most difficult exterior design problems.



Bumpers
Impact
Abrasion
Stone Pecking
Pitting

Exhaust Systems
Heat Differentials
Acids
Pooling
Road Salts
Moisture
Impact

Step Plates and Gravel Shields
Abrasion
Moisture
Erosion

Door Sills and Rocker Panels
Internal Moisture
Stone Pecking
Abrasion
Street Chemicals

Underbody
Wheel Splash
Road Salts
Road Dirt
Crevice Corrosion
Stone Pecking

Wheel Covers
White Sidewall
Detergents
Road Salts
Scratching
Pitting
Stone Pecking

Exterior Trim
Denting
Weather
Street Chemicals
Scratching
Pitting

CORROSION RESISTANT STEELS PROTECT VITAL BODY PARTS

The areas of automotive vehicles that are subjected to abrasion, denting, pitting, moisture entrapment and crevice or joint corrosion are of major concern in corrosion protection. Protection to these areas is particularly important in unitized body construction since structural framing member strength may be jeopardized by premature corrosion. The precoated metals, especially galvanized steels, are successfully controlling corrosion. Parts now made of precoated steel, but formerly made of low carbon steel, give much longer life under normal use.

Galvanized steel is especially prepared to take an ultra-smooth, lasting paint finish. The hot-dip zinc coating prevents rusting when the paint is damaged and gives protection from corrosion where there is no paint at all. It is compatible with phosphate protective systems in common automotive use. Body assemblies, whether cold rolled carbon or galvanized steel, can be treated for painting at the same time. Separate, special painting preparations are not required. Galvanized steel withstands severe deformation without loeing its corrosion resistance, for the Zinc coating flows with the base metal without chipping, peeling, flaking or powdering.

Although precoated steels are corrosion resistant as long as their coatings are unbroken, there is a tendency for sheared edges, punched holes, score marks and sometimes severely stretched areas to constitute potential corrosion areas. This tendency is offset in galvanized steels by the "self-healing" galvanic action of the coating.

BETTER CORROSION RESISTANCE AND A BRIGHTER FINISH

Exterior bright trim parts require superior dent and corrosion resistance, good strength characteristics and good ductility. USS Bright Annealed Stainless Steel strip has these characteristics, plus a mirror-like finish that holds through forming operations with only normal precautions. Since the bright finish minimizes the need for costly buffing and pickling operations finishing costs are greatly reduced. This USS Bright Annealed Stainless Steel strip passes the CASS and other corrosion tests and provides the greatest corrosion resistance of any of the straight chrome Stainless Steels.

Only Stainless Steels come close to meeting the many requirements of wheel covers and caps, many of which are almost mutually incompatible: springiness, formability, dent resistance, dimensional stability, corrosion resistance, scratch resistance and brightness. Wheel covers and caps made of USS Stainless Steel shrug off the effects of road chemicals, moisture, detergents and white sidewall cleaners. Moreover, they stay strong, rigid and retain their rich luster.

USS Stainless Steel contributes its crisp styling, prestige and beauty to front and rear end designs. Engineers are becoming increasingly aware of its prestige-building appeal for grilles, head and tail light bezels.

It is a difficult design problem to integrate the need for structural durability in bumpers with the over-all body concept. From both the structural and aesthetic standpoint USS PAR-TEN steel plays a part here. Fabricated USS PAR-TEN steel bumpers offer an unmatched combination of strength and beauty. They are easily formed and may be worked into a variety of front and rear designs. These bumpers are repairable by straightening, welding and buffing—all relatively simple operations. For protection and impact strength with light cross-sections, USS PAR-TEN steel offers excellent design possibilities for bumpers and bumper guards.

BETTER RUST PROTECTION BY BETTER PLATING

Better performance and appearance can be realized from nickel-chromium plating over USS cold rolled carbon steel or USS PAR-TEN steel using semi-bright plus bright nickel in multi-layer coatings, rather than by increasing the thickness of a single nickel layer. The thickness ratio of the two layers of nickel is an important factor. Successful results have indicated that the ratio of semi-bright to bright should be approximately four to one. Two important advantages of the multi-layer coatings are greater resistance to corrosion and impact.

IMPROVING EXHAUST SYSTEM LIFE

In addition to cleaning the engine and conducting obnoxious gases to the rear of the vehicle, the muffler and exhaust system become a key breathing engine and crossover in full power. The merits of an exhaust system can be determined by how well it quiets both high and low frequencies with the least power loss, for the least amount of space it requires and for how well it lasts.

Primarily to satisfy users of V-8 engines has led to the use of dual exhaust systems which, in their complexity, have doubled the more common in the earlier more conventional systems. These high performance engines also necessitated higher octane gasolines with more and more lead compound added. While lead in itself is not a corrosive element, certain properties of the fuel and the additives in the fuel change during combustion to highly corrosive acids, such as sulphurous, hydrochloric and hydrobromic acids. Tests have indicated, for instance, that increased quantities of ethylene dichloride, which produces hydrochloric acid in the exhaust, also greatly increase muffler corrosion rates. Another part of the problem is increased engine displacement and compression ratios which increase fuel consumption, especially in start-and-stop driving. As more fuel is burned more exhaust gases are produced and the quantities of corrosive by-products are increased. Warm-up of the dual exhaust system is slower than in single exhaust systems. This delay causes a greater deposition of corrosive condensate to collect in the muffler.

Driving habit patterns are a prime factor in muffler corrosion, especially start-and-stop, short distance driving. In addition to these highly corrosive chemicals the internal combustion engine also produces about one gallon of water for every gallon of fuel consumed. These chemicals and the water must pass through the exhaust system to the atmosphere. In passing through the cool exhaust system, this solution of chemicals and water coats the internal muffler surfaces and collects at the bottom of the mufflers. Under the worst start-and-stop driving conditions this condensate remains in the muffler and tailpipe longer, vaporizes slowly and therefore exerts a great corrosive effect on the steel.

Many ideas have been tried to rid mufflers quickly of this collected acid condensate, among which are: ventilation to accelerate gas passage; drain holes in the muffler bottom; and scrapers to suck the condensate from the bottom of the muffler and expel it. However, these do not wholly solve the problem because checks of failed mufflers indicate they also fail at the top where condensate does not collect in a puddle.

Research has also shown that maximum exhaust system corrosion takes place within the temperature range of 100°F to 300°F, with a peak of about 180°F. In start-and-stop, short distance driving the exhaust system seldom gets beyond this temperature range of greatest corrosion.

At present a practical solution to the problem of increasing exhaust system life is to use steels that are resistant to corrosion from combustion by-products. The ability of USS Stainless Steel to withstand elevated temperature differentials for long periods of time and its ability to resist highly corrosive environments under such conditions makes it economically the best steel for service on mufflers and tailpipes. Service temperatures run as high as 1300°F with the presence of accompanying corrosive acids formed from present day fuels, such a factor that only

Stainless steel should be actively considered for passenger-compact exhaust systems. It is formable and dependable, and, commercially, the service life should give the high degree of protection good, if in one particularly severe, that, where cost is the determining factor and a high degree of protection is still required, a combination of steels in the system is sure cases, the corrosion resistance package consisting of heads, inlet shell and inner skirt can be made of Stainless Steel and the outer jacket and other internal parts can be made of aluminized steel or galvanized steel.

A good overall choice for processing mufflers may be made high production cost both sides would be aluminized treated steel mufflers or combinations of aluminized coated and galvanized steel mufflers. Corrosion condensation and their effect on mufflers can now be controlled by an acceptable limit on metal oxide application by the use of these processed steels along with improved muffler design. Such durable quality corrosion-resistant mufflers and tailpipes can be manufactured at a practical cost. Use of these corrosion-resistant processed steels inside the muffler as well as in the outer package which consists where steel at its possibly starts inside. Aluminum coated steels are used for high temperature as well as low temperature corrosion conditions. Hot dipped galvanized steels are used for most cold temperature corrosion conditions. The use of aluminized steels for the shell which protects the muffler against impact, abrasion, road salts, heat, cold and moisture. A laminated adhesive-bonded wrapped shell construction assures better acoustical deadening. This construction consists of a layer of asbestos covered by an exterior layer of steel. It is one of the reasons why the higher cost muffler systems are rarely used. The adhesive wrapping also insulates the muffler so it heats up faster and maintains a more uniform muffler temperature which results in a more efficient. This wrapping prolongs muffler life as much as 5% to 10%.

Certain steel muffler parts can be treated to make them highly resistant to the corrosive acids present in exhaust systems. To do this, the muffler's internal shell assembly and other internal parts and tailpipes are dipped in a ceramic refractory coating so that all of the inner and outer surfaces, baffles and tubes are completely coated to an approximate thickness of 0.002 to 0.004 inch.

The problem which exists in the manufacture of ceramic mufflers is to get the internal parts of the muffler completely coated with the ceramic material. To insure proper flow of the ceramic coating on the inner parts, special mufflers should be designed. Such ceramic coated mufflers permit the use of less expensive carbon steels.

Much work is being done to improve ceramic coated carbon steel mufflers and some cars are now equipped with them. Although there are many unresolved problems in ceramic coating, time may prove this a most satisfactory method of providing corrosion resistance in exhaust systems.

Most passenger car muffler corrosion takes place in a narrow range of temperatures close to 180°F. Therefore, it would be ideal if all muffler parts and other exhaust system parts could be maintained above these temperatures at all times in order to drive the condensate from the exhaust system. This, of course, is impossible. However, muffler design can be such that temperatures are maintained at the highest degree possible for the particular type of operation involved. Asbestos outer wraps are used to help maintain temperature in the muffler, as well as for acoustical deadening. Some methods of design whereby most of the internal parts are heated up as rapidly as possible have been devised. Whenever possible these designs are utilized in order to prevent corrosion. It is not always possible to attain the acoustical silencing necessary in a muffler and at the same time design for the best heat distribution.

Improved internal designs, stronger steel structures and the use of processed carbon steels help mufflers to absorb internal temperature differentials, to withstand road shock and vibration, to absorb thrust and withstand full engine horsepower. By using processed carbon steels in mufflers, corrosion is greatly retarded.

As yet it is not within the ability of human beings to measure or predict the future, much less to control it. So, we are not assuming the prophet's role. Ours is but a voice that speaks of the imminent horizons and all the wonderful things to come.

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Sydney Jay Mead was an American industrial designer and neo-futuristic concept artist, widely known for his designs for science-fiction films such as Blade Runner, Aliens and Tron.

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